SCIENCE

4 December 1959

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

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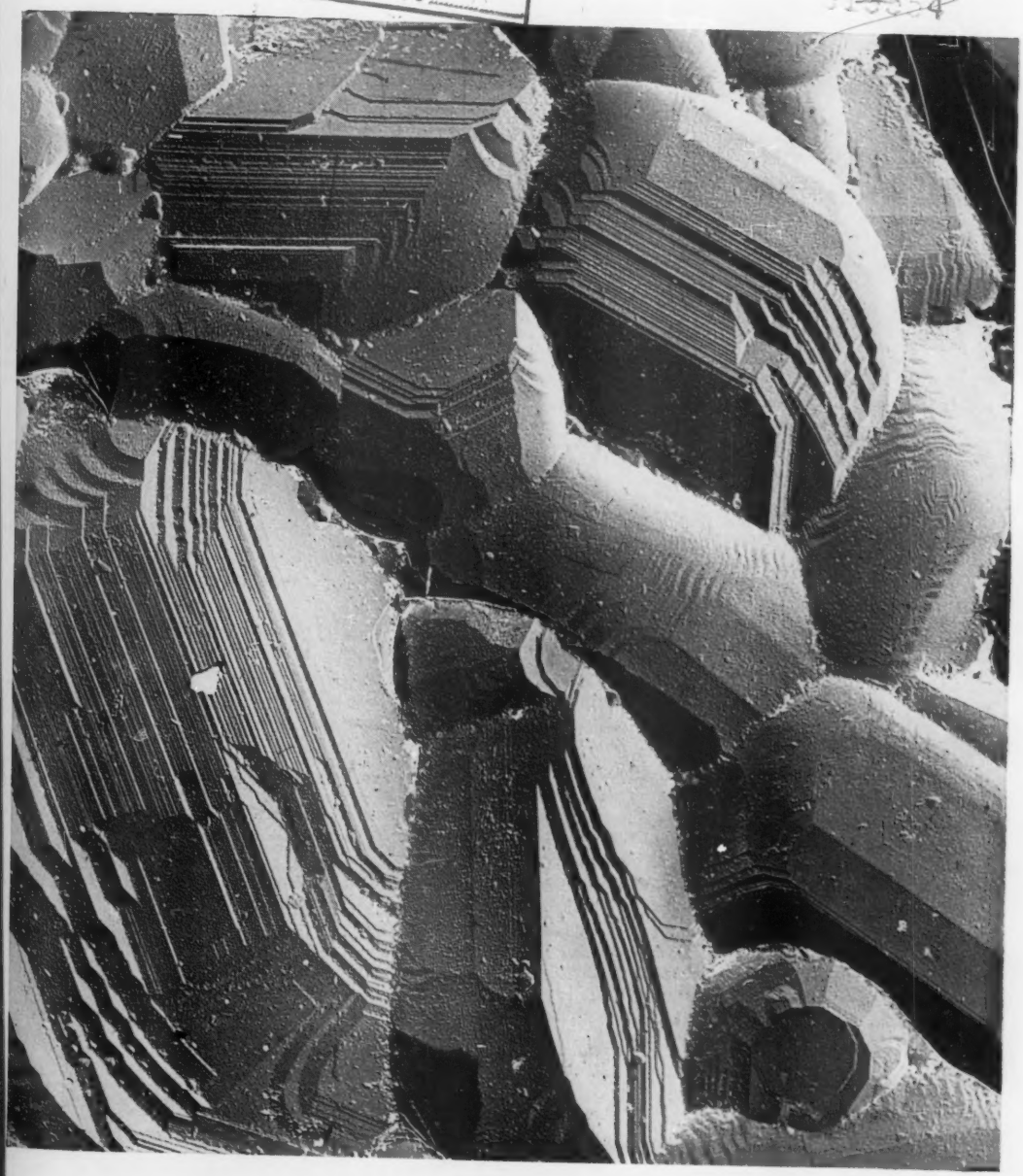
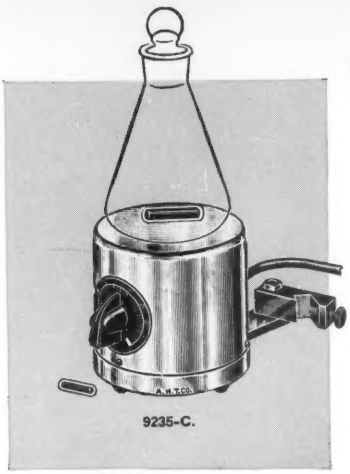


Preconvention Issue

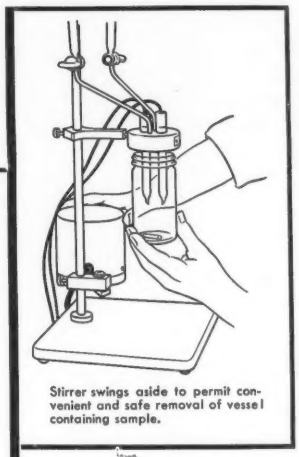


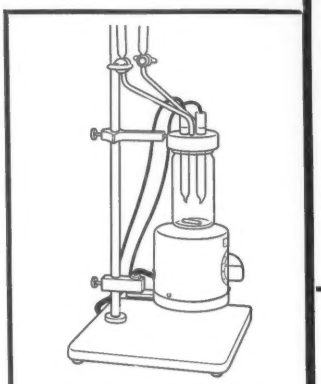
9235-C.

EXCLUSIVE FEATURE...

swivel clamp with swinging arm

- Permits rapid removal of vessel containing sample


Stirrer swings aside to permit convenient and safe removal of vessel containing sample.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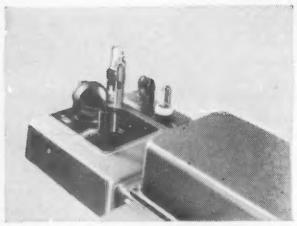

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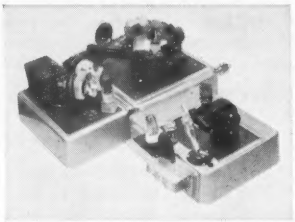

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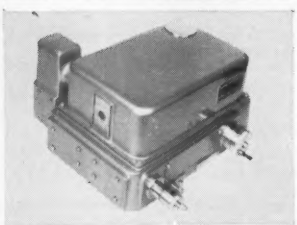

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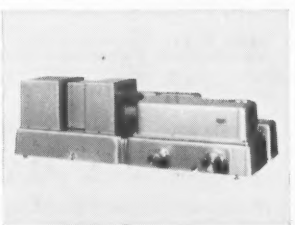

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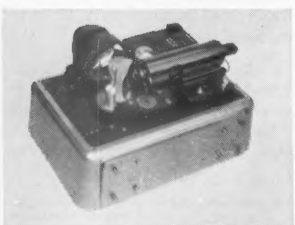

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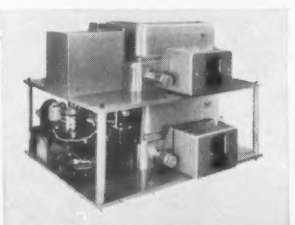

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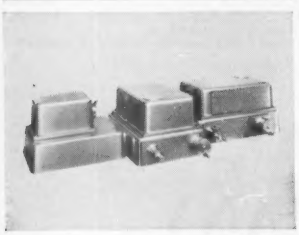

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4 December 1959, Volume 130, Number 3388

SCIENCE

Editorial Headlines and Highlights 1533

Articles Living Clocks: *F. A. Brown, Jr.* 1535

The clocks are accounted for as "open systems" depending upon subtle geophysical rhythms.

Environmental Radiation and Cancer: *H. F. Blum* 1545

No threshold is demonstrable, and incidence may have rising inflection with intensity.

AAAS Chicago Meeting: *R. L. Taylor* 1547

Science in the News United States and Soviet Union Agree to Reciprocal Exchange in Peaceful Uses of Atomic Energy; Efforts To Control Locusts in Africa Described 1563

Book Reviews *Organizing Peace in the Nuclear Age*, reviewed by *I. de Sola Pool;* other reviews 1568

Reports Natural Selection and the Origin and Evolution of Weeping in Man: *A. Montagu* 1572

Parietal Eye Nerve in the Fence Lizard: *R. M. Eakin* and *R. C. Stebbins* 1573

Structural Similarities between Hemoglobins A and F: *A. M. Katz* and *A. I. Chernoff* .. 1574

Oxygen Isotope Paleotemperature Determinations of Australian Cainozoic Fossils: *F. H. Dorman* and *E. D. Gill* 1576

Departments Letters 1530

Speleology; Forthcoming Events; New Products 1580

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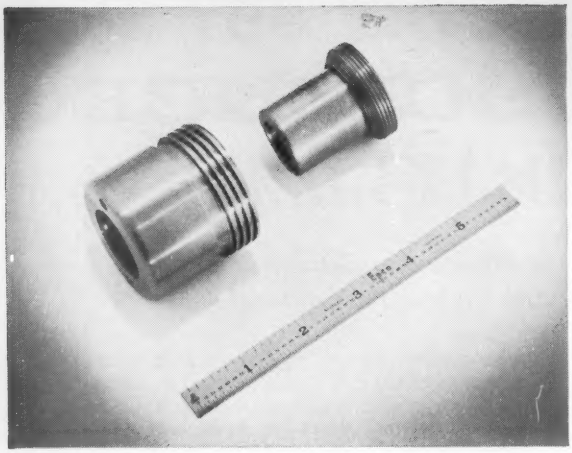
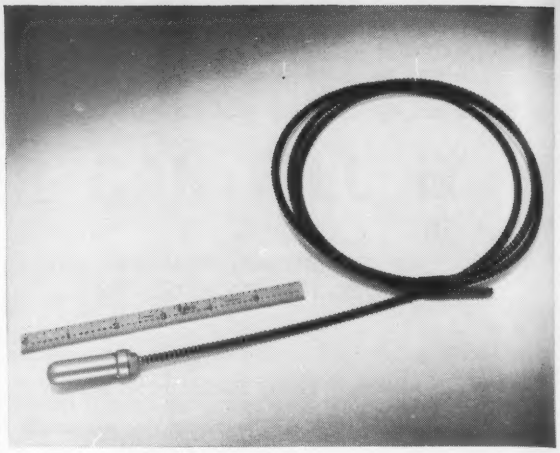


Teletherapy



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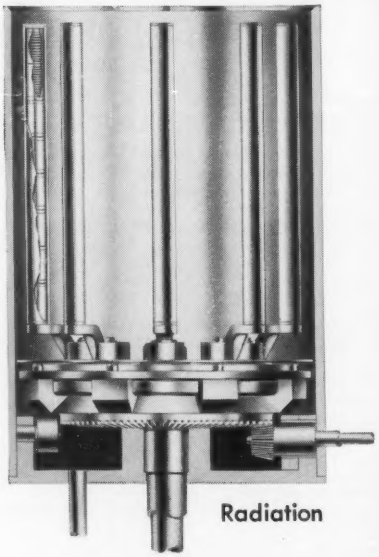

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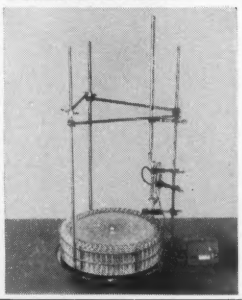

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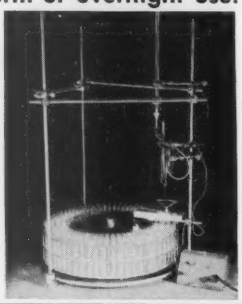

240 test tubes, 18 x 150 mm.

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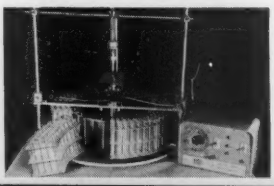

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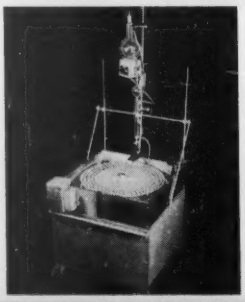

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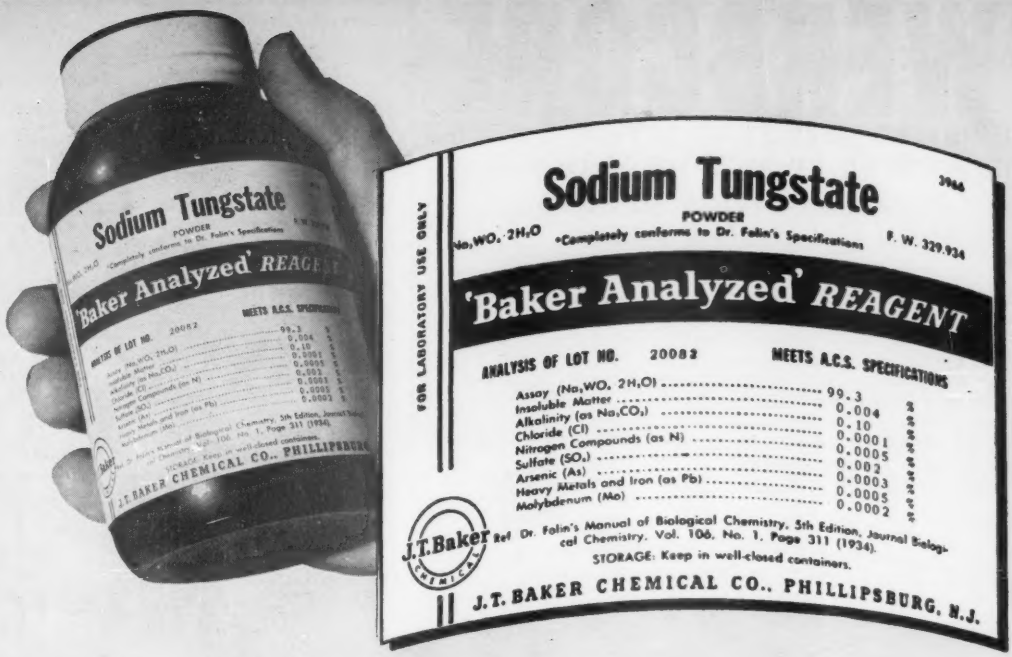
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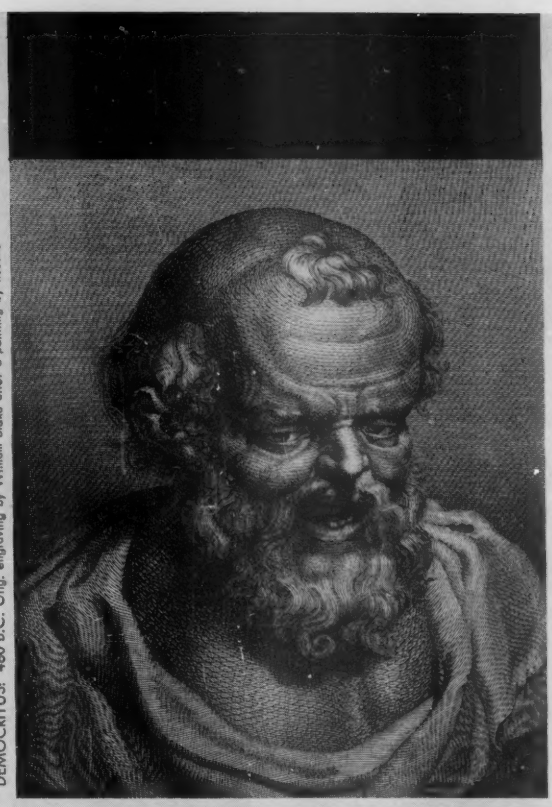

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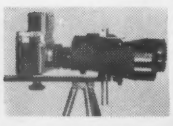

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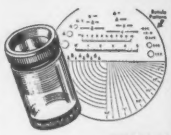

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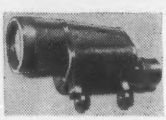

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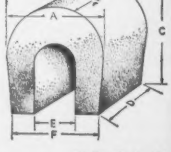

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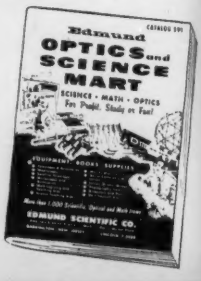

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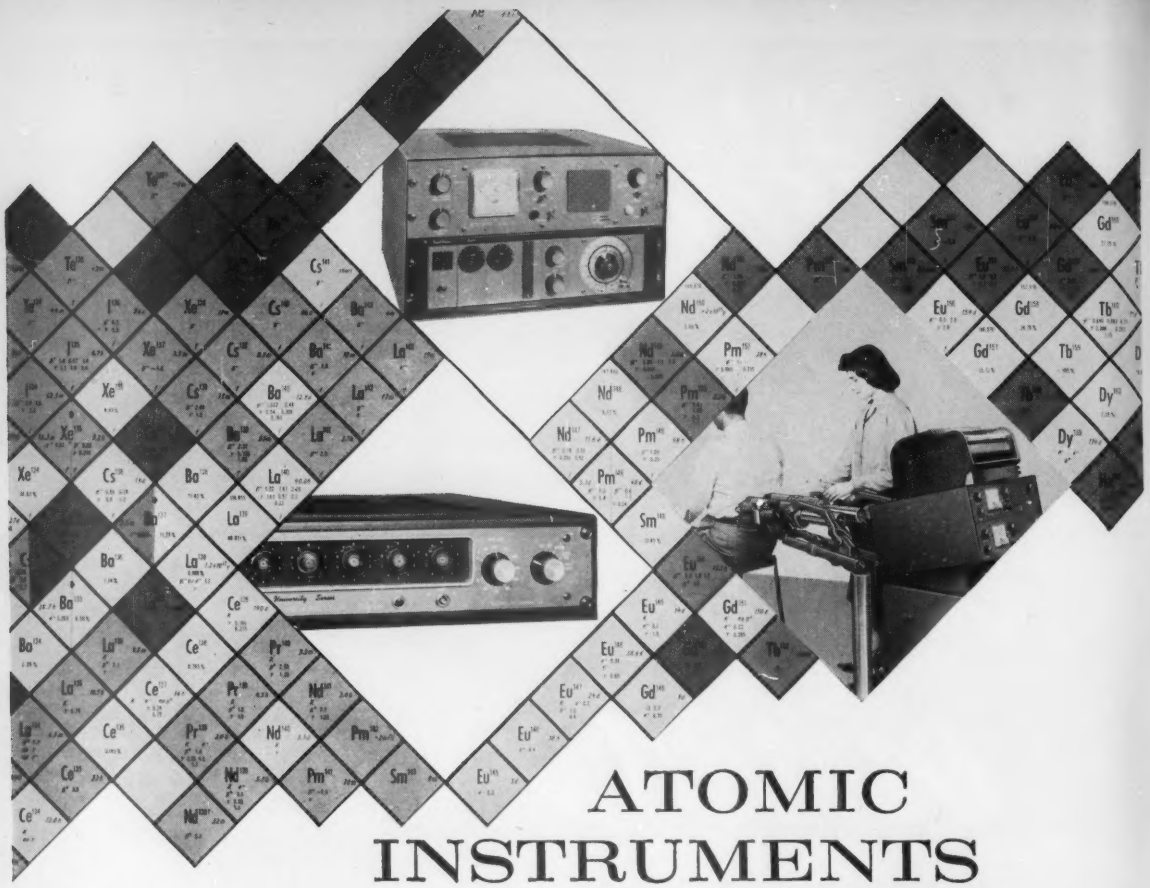

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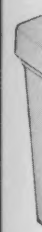

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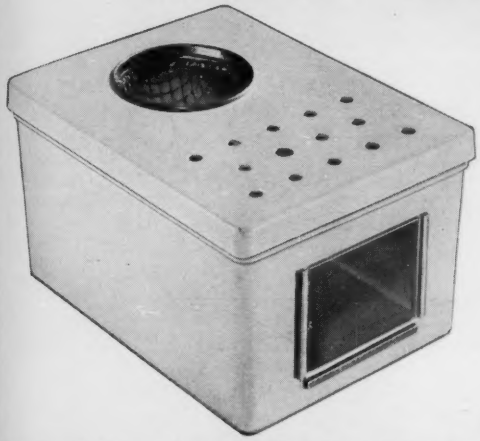

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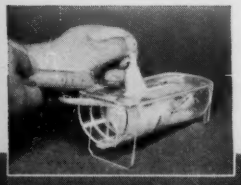

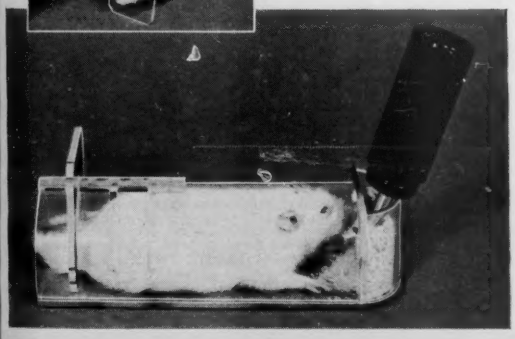

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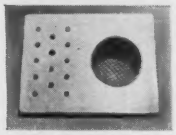

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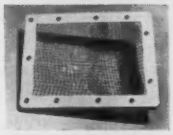

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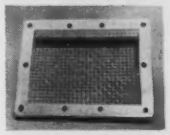

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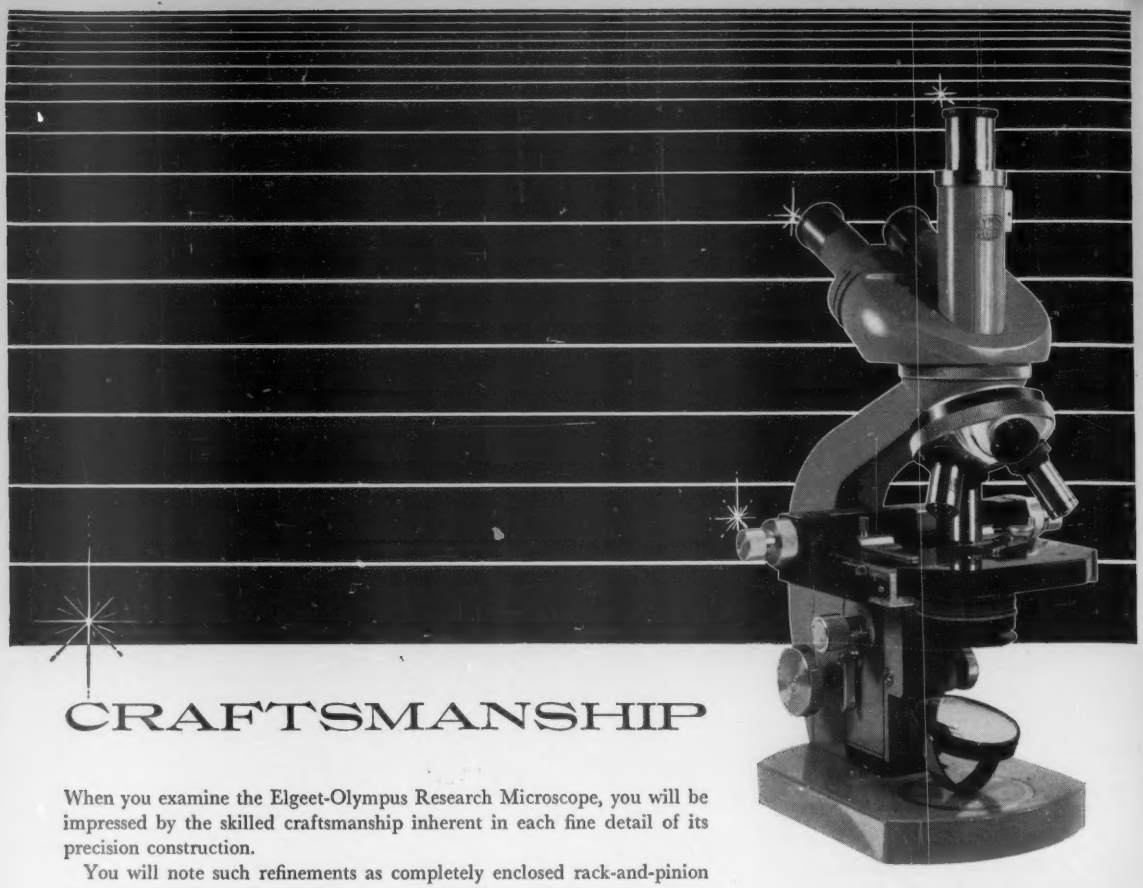

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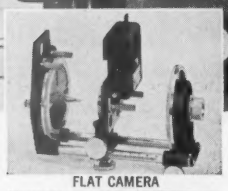
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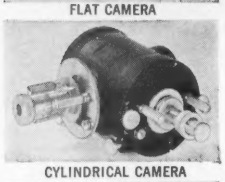
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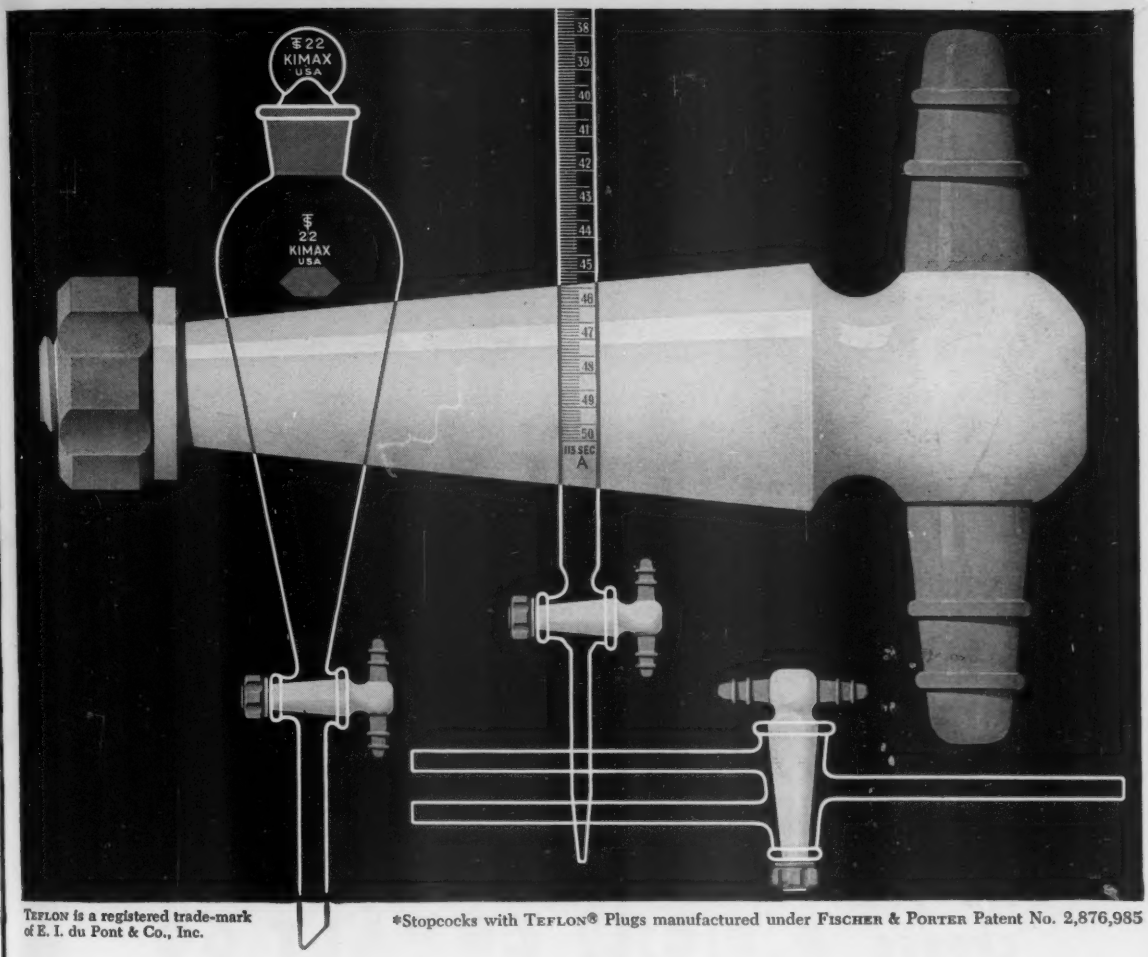

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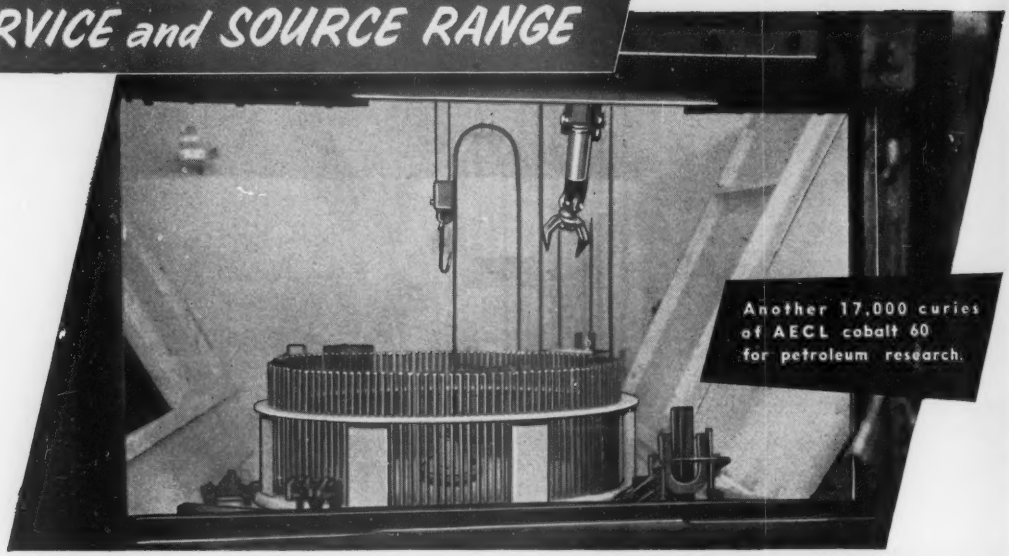

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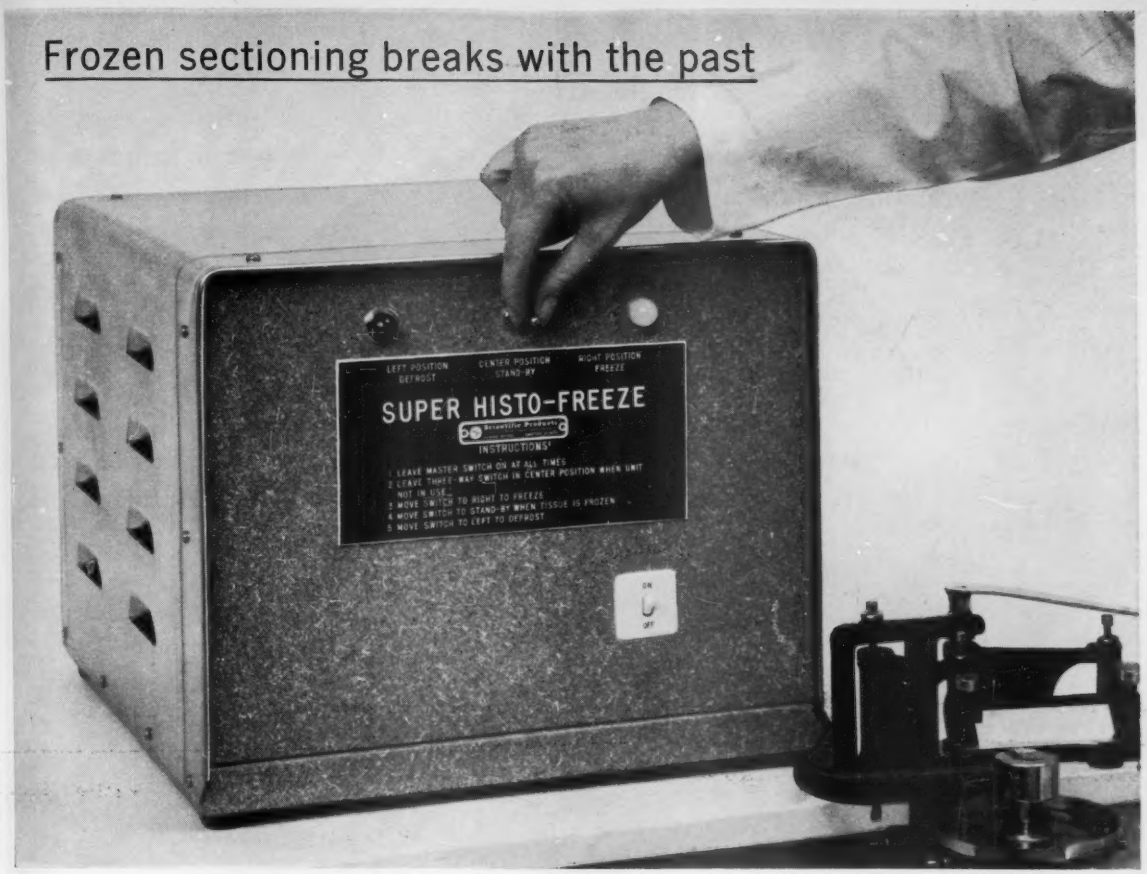

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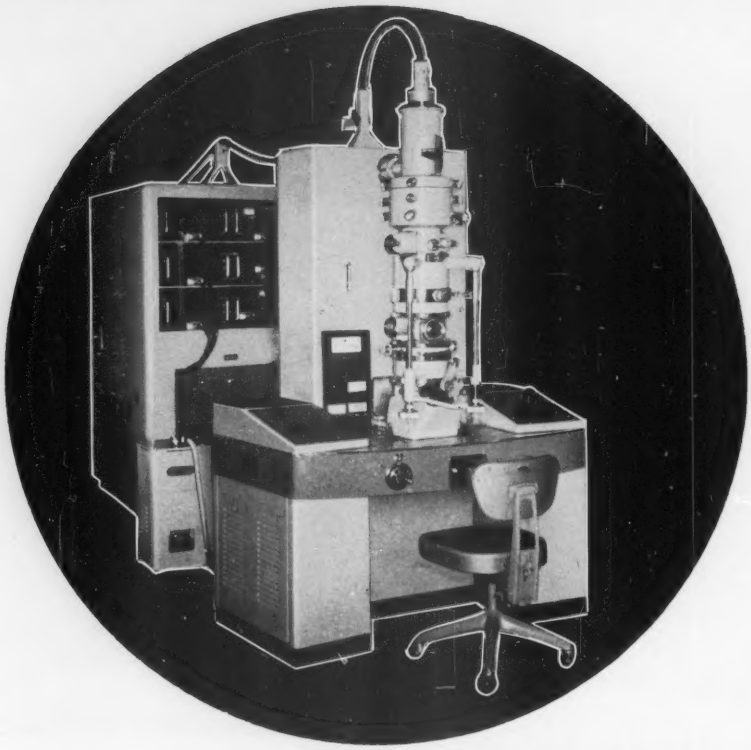

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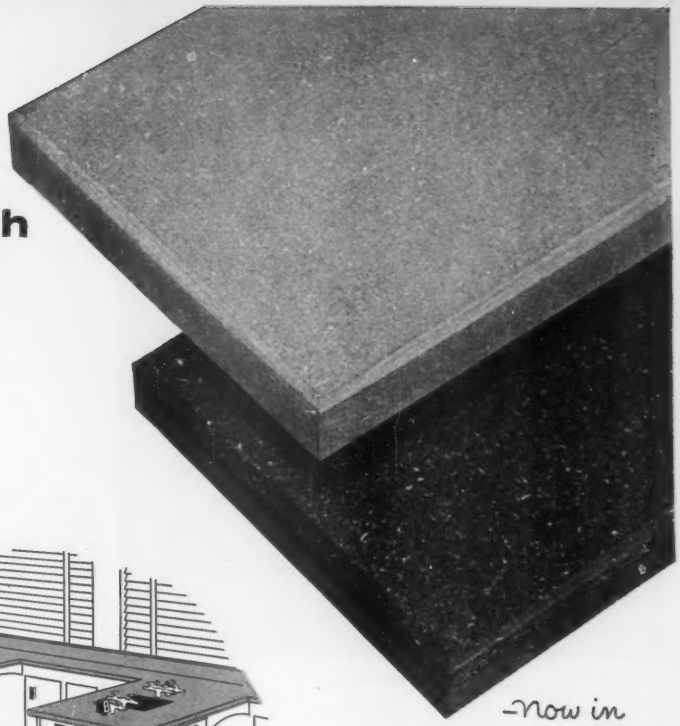

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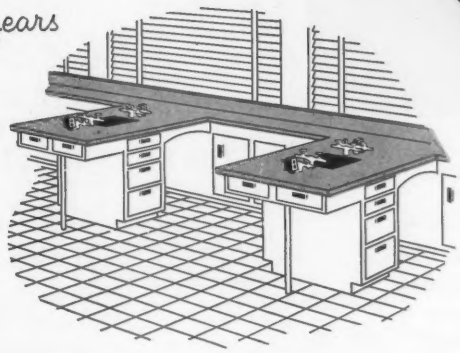

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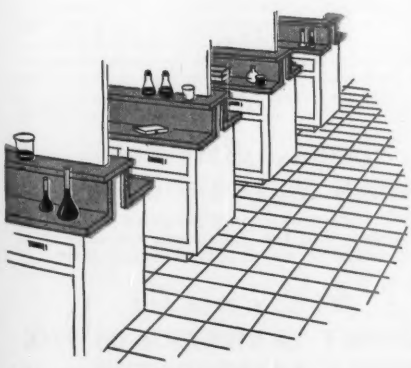

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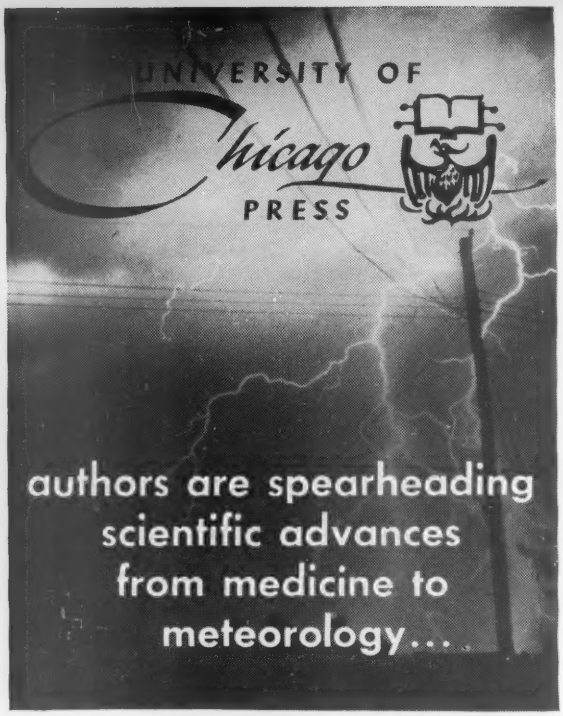

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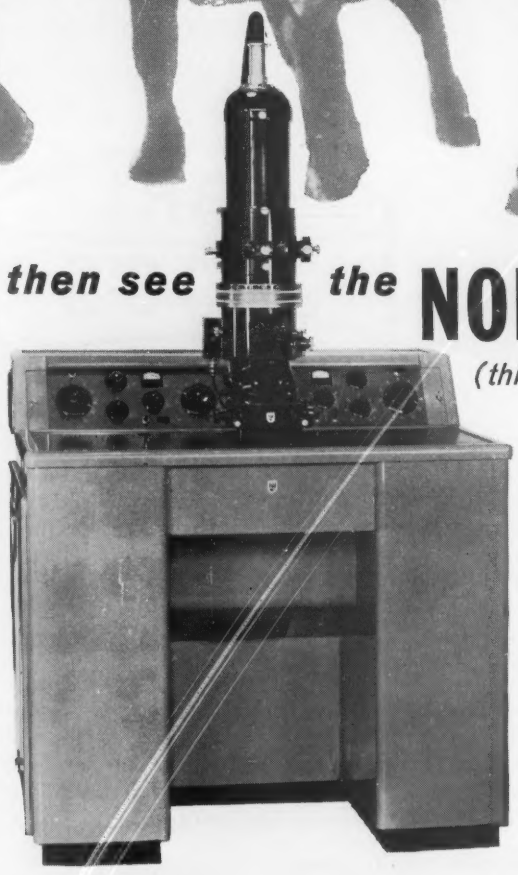

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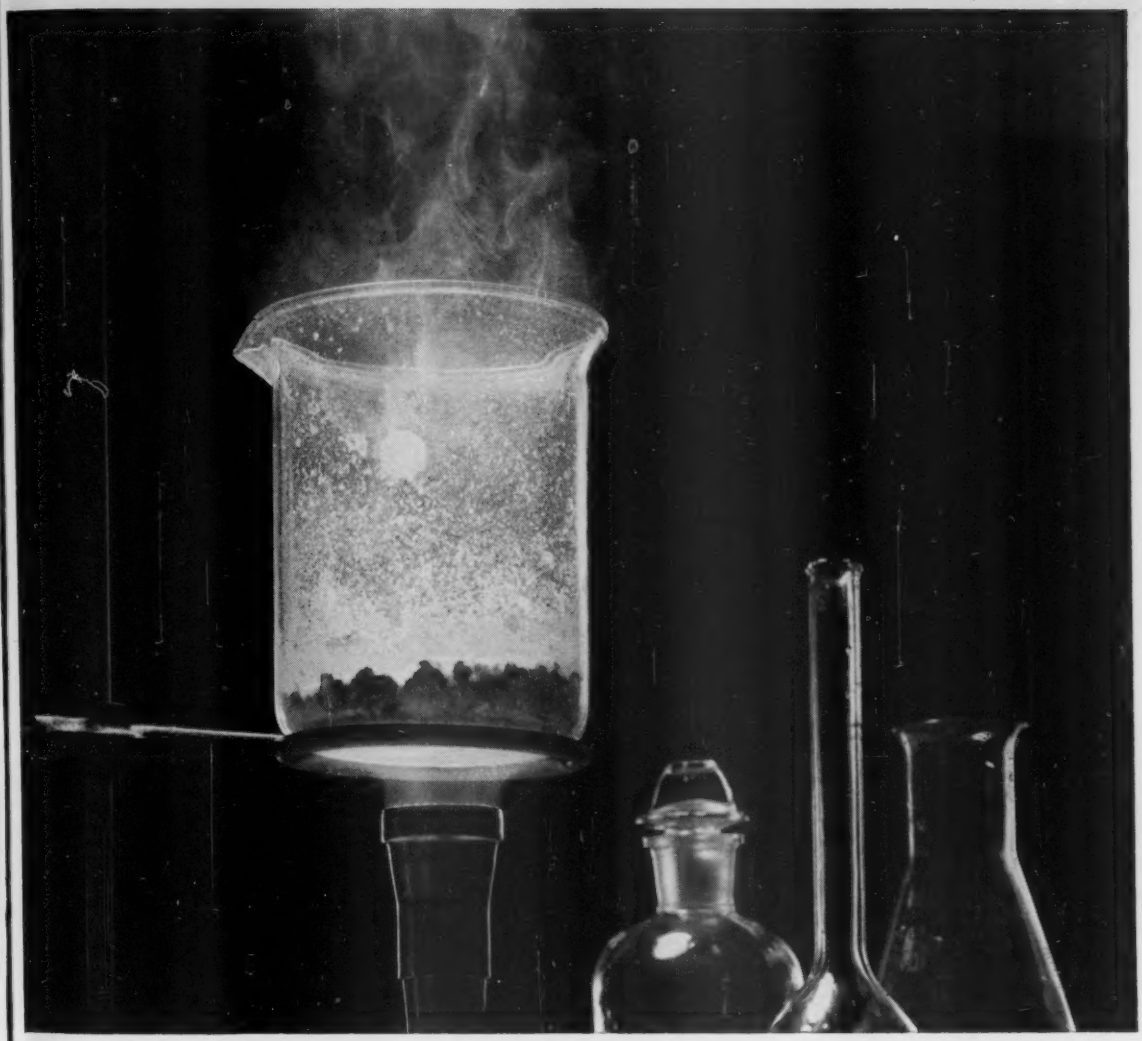

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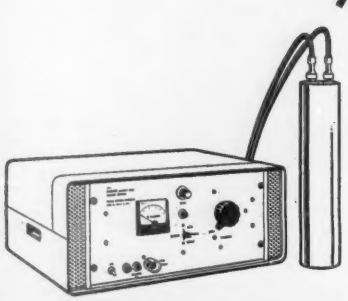

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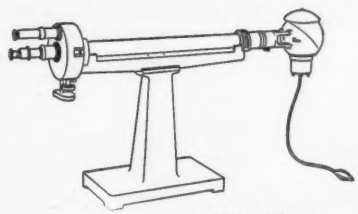

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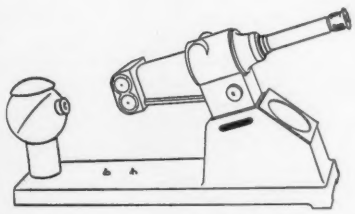

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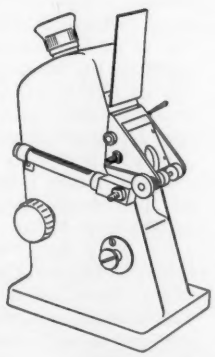

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Letters

Policy and the First Bombs

In a recent issue of *Science* [**130**, 32 (3 July 1959)] Edward Condon reviews Amrine's book *The Great Decision*, which discusses in part the making of high policy by the United States Government on how to deal with the first atomic bombs. Both author and reviewer emphasize the importance of studying and understanding this piece of history. With this view I am in deep agreement. From earlier experience of my own, and from conversations with contemporary historians who have looked into the problem, it seems clear that the available documentary record is meager. I should not be astonished if the existing record is itself quite meager. Just for this reason it seems to me important not to let serious errors or misrepresentations pass unnoticed.

On one such error, which has to do with the information made "available to our policy makers at the time policy decisions on how to use the bomb were being made," I feel competent to make a comment. Since Condon's review repeats and elaborates a mistake also to be found in Feis' authoritative *Churchill, Roosevelt, Stalin*, I shall do so at some length.

The paragraphs in Condon's review which I wish to discuss are the following:

> . . . Amrine tells us (page 132) that General Groves, in a memorandum to General George Marshall dated 30 December 1944, vastly underestimated the power of the bomb. He estimated the power of the bomb at only 500 tons of TNT, whereas it was actually 20,000 tons when used on Hiroshima. As Amrine says, our military planners "were only given reason to think it was a spectacular improvement in bombs, not another kind of warfare".
>
> Now I know that General Groves did not know enough physics to make his own estimate; and I do not believe that anyone at Los Alamos would have made such a low estimate. How then could Groves have erred by a factor of 40? Could it have been intentional, so that the top policy planners would not be aware of the horribly serious nature of the decision they were taking?

I have turned to the memorandum of 30 December 1944 from General Groves to General Marshall, which is published in the first volume of *Foreign Relations of the United States: The Conferences at Malta and Yalta, 1945*. The first paragraph reads:

> It is now reasonably certain that our operation plans should be based on the gun type bomb, which, it is estimated, will produce the equivalent of a ten thousand ton TNT explosion. The first bomb, without previous full scale test which we do not believe will be necessary, should be ready about 1 August 1945. The second one should be ready by the end of the year and succeeding ones at . . . intervals thereafter.

In the first days of August 1945 the final deliveries of components of the gun-type bomb reached the Pacific. This bomb was used against Hiroshima. Its yield is not known very accurately; it was not far from 17,000 tons. The calculation of the yield of nuclear weapons made a priori, and unverified, was not as difficult for this type of weapon as for the implosion bombs; it was nevertheless subject to some uncertainty. The discrepancy between General Groves' prediction of 10,000 tons and the actual value reflects some underestimate in our calculations of the yield, and a corresponding over-design.

General Groves' second paragraph reads:

> Our previous hopes that an implosion (compression) type of bomb might be developed in the late spring have now been dissipated by scientific difficulties which we have not as yet been able to solve. The present effects of these difficulties are that more material will be required and that the material will be less efficiently used. We should have sufficient material for the first implosion type bomb sometime in the latter part of July. This bomb would have an effect which would be equivalent to about 500 tons of TNT. During the remainder of 1945 it is estimated that we can produce . . . additional bombs. The effectiveness of these should increase towards 1000 tons each as development proceeds and, if some of our problems are solved, to as much as 2500 tons.

As I recall it, these estimates were based on extensive conversations between General Groves and senior members of the Los Alamos Laboratory, and reflected the then prevailing opinion, and the results of the most recent experiments and calculations. We had been convinced of our inability to make implosion bombs as we had originally designed them. I believe that it was not until about a decade later that such designs were tested.

By early July, however, we had solved, as General Groves suggested we might, "some of our problems"; and with a more conservative model were prepared to test a first bomb. Even at that time, however, our estimates of the yield were quite uncertain, and for the most part quite low. We established a pool in the laboratory, to record guesses as to the yield of the first bomb. An overwhelming majority made estimates under a few thousand tons; figures in the hundreds of tons were popular. Two visitors, Lee Dubridge and I. I. Rabi, picked the extreme

(*Continued on page 1592*)

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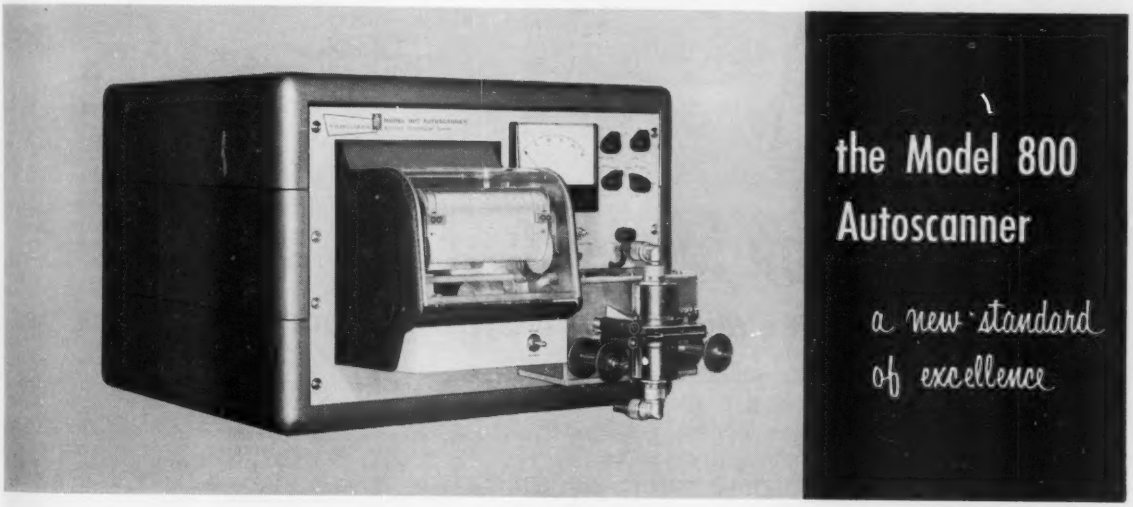

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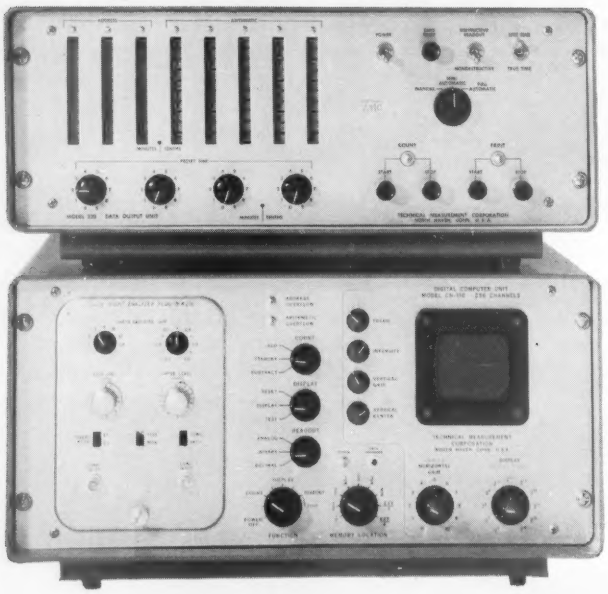

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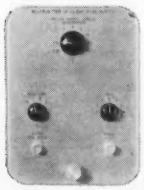

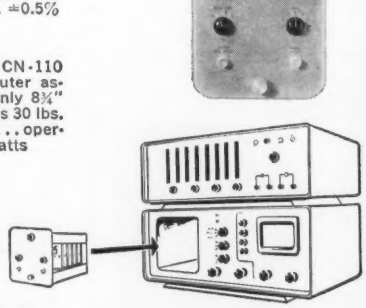

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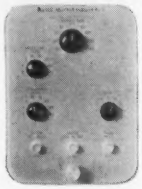

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Headlines and Highlights

Scientists busy with research, meeting classes, serving on committees, participating in conferences, and otherwise preoccupied, occasionally find time to read stories with scientific aspects in the public press—or loyal members of their families will quote from these accounts across the breakfast table. Scientists have a general awareness of what the public attributes to science.

Contaminated cranberries have been added to air pollution, fallout, the latest rocket launchings, advances in medical research. And now the "population explosion" is appearing in mass-circulation magazines and on the air waves. It is encouraging that the general public has an increasing opportunity to become informed of problems, large and small, nearly all of which are applications of scientific discoveries or are currently the subjects of intensive study.

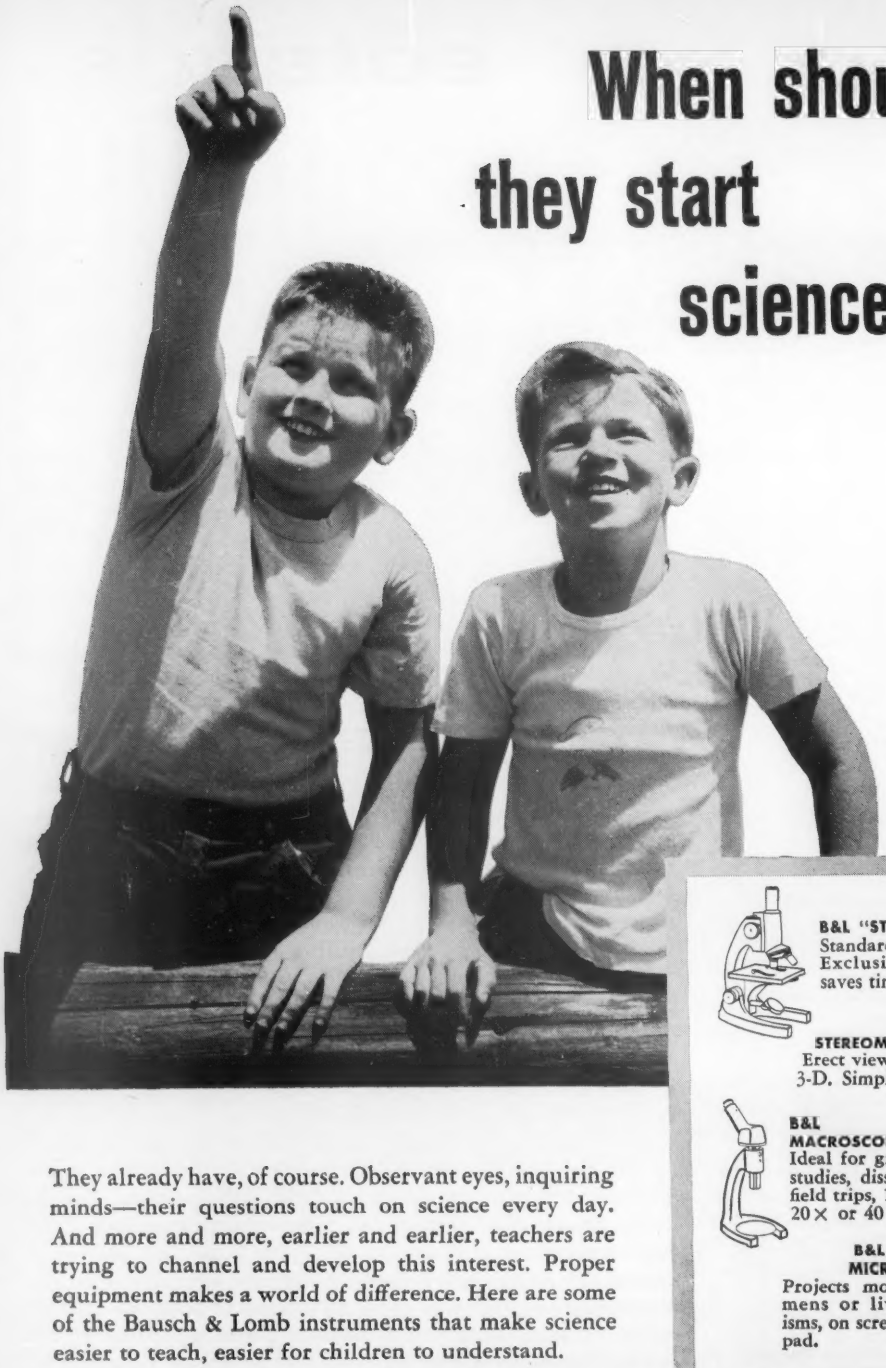
Scientists have had advance knowledge of these things. The sources of today's headlines have been in scientific journals or have been reported at scientific meetings. Each AAAS meeting—from the first one in 1848—has included papers on matters of general concern to scientists, often on subjects that affect society.

The proceedings of the past 125 meetings would reveal both concepts of ephemeral significance and serious problems that have continued. Among the diverse programs of a single AAAS meeting—no one can attend all of them—reports of new research and new methods for attacking old problems can be expected. To cite but a few instances: Tranquilizers and psychopharmacology gained prominence at the Berkeley meeting of 1954; plans for the IGY program and the crisis in science education were outlined at the 1955 meeting; in 1956, population growth (a perennial topic) and resource development were discussed; the first symposium on guided missiles appeared in 1957; and, at last year's Washington meeting, there was more on space science, biochemistry, computers, major problems of the American economy, and the phenomena of mental disorder.

What's new this year? A glance at the special sessions and the topical list of symposia in this issue will suggest the collective thinking of the many program chairmen on what is timely and important. For example, Section Np–Pharmacy has a two-session symposium, "The Scientist's Part in Protection of the Public," on food additives—planned last spring. Section O–Agriculture has five sessions on the development and protection of the germ plasm of plants and animals useful to man, a subject that is indirectly related to food for an expanding population. Among the exhibits of the Annual Exposition of Science and Industry, described on later pages, are some decidedly novel and important items. Large firms participate to show some of their latest advances in technology.

As the meeting approaches, inquiries about its content increase in volume. At least the highlights are requested. This issue of *Science* and the synopses of programs published each week since 30 October should help. One thing can be said: Today's highlights will be tomorrow's headlines!—RAYMOND L. TAYLOR, AAAS

When should they start science?



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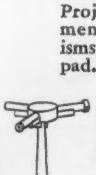

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CURRENT PROBLEMS IN RESEARCH

Living Clocks

The clocks are accounted for as "open systems" depending upon subtle geophysical rhythms.

Frank A. Brown, Jr.

Familiar to all are the rhythmic changes in innumerable processes of animals and plants in nature. Examples of phenomena geared to the 24-hour solar day produced by rotation of the earth relative to the sun are sleep movements of plant leaves and petals, spontaneous activity in numerous animals, emergence of flies from their pupal cases, color changes of the skin in crabs, and wakefulness in man. Sample patterns of daily fluctuations, each interpretable as adaptive for the species, are illustrated in Fig. 1. Rhythmic phenomena linked to the 24-hour and 50-minute lunar-day period of rotation of the earth relative to the moon are most conspicuous among intertidal organisms whose lives are dominated by the ebb and flow of the ocean tides. Fiddler crabs forage on the beaches exposed at low tide; oysters feed when covered by water. "Noons" of sun- and moon-related days come into synchrony with an average interval of 29½ days, the synodic month; quite precisely of this average interval are such diverse phenomena as the menstrual cycle of the human being and the breeding rhythms of numerous marine organisms, the latter timed to specific phases of the moon and critical for assuring union of reproductive elements. Examples of annual biological rhythms, whose 365¼-day periods are produced by the orbiting about the sun of the earth with its tilted axis, are so well known as scarcely to require mention.

These periodisms of animals and plants, which adapt them so nicely to their geophysical environment with its rhythmic fluctuations in light, temperature, and ocean tides, appear at first glance to be exclusively simple responses of the organisms to these physical factors. However, it is now known that rhythms of all these natural frequencies may persist in living things even after the organisms have been sealed in under conditions constant with respect to every factor biologists have conceded to be of influence. The presence of such persistent rhythms clearly indicates that organisms possess some means of timing these periods which does not depend directly upon the obvious environmental physical rhythms. The means has come to be termed "living clocks."

Autonomous-Clock Hypothesis

From the earliest intensive studies of solar-day rhythmicality during the first decade of this century by Pfeffer (*1*), with bean seedlings, certain very interesting properties of this rhythm became clearly evident. Pfeffer found that when his plants were reared from the seed in continuous darkness, they displayed no daily sleep movements of their leaves. He could easily induce such a movement, however, by exposing the plants to a brief period of illumination. Returned to darkness, the plants possessed a persisting daily sleep rhythm. The time of day when the leaves were elevated in the daily rhythm was set by the time of day when the single experimental light period commenced. It was apparent that the daily rhythmic mechanism possessed the capacity for synchronization with the outside day-night cycles while having its cyclic phases experimentally altered by appropriate light changes made to occur at any desired time of day. These alterations would then persist under constant conditions. Since Pfeffer's time, this property has been abundantly confirmed for numerous other plants and animals. The daily rhythms, therefore, exhibit the capacity for synchronization with external, physical cycles while having freely labile phase relations.

A second discovery, also made by Pfeffer, was that the daily recurring changes under constant conditions could occur earlier, or later, day by day, to yield regular periods deviating a little from the natural solar-day ones. Periods have now been reported ranging from about 19 to 29 hours. The occurrence of persisting rhythmic changes under constant conditions, with regular periods of other than precisely 24 hours, clearly indicated that these observed rhythmic periods could not be a simple direct consequence of any known or unknown geophysical fluctuation of the organism's physical environment.

A third fundamental contribution to the properties of the daily rhythms was made by Kleinhoonte (*2*). While confirming, in essentials, all of Pfeffer's findings, she discovered that the daily sleep movements of plants could be induced to "follow" artificial cycles of alternating light and dark ranging from about 18-hour "days" to about 30-hour "days." When the "days" deviated further than these limits from the natural solar-day period the plants "broke away" to reveal their normal daily periodicity, despite the continuing unnatural light cycles. This observation clearly emphasized the very deep-seated character of the organismic daily rhythm.

The author is Morrison professor of biology at Northwestern University, Evanston, Ill.

In the light of his demonstration of both phase and frequency lability for sleep rhythm in beans, Pfeffer concluded that the periods of plant rhythms must depend upon an independent internal timing mechanism.

This hypothesis was hotly contested for many years by Stoppel (*3*) and others. Stoppel found evidence to suggest that a daily rhythmicality related to the known daily rhythm in air ionization was continuously imparted to the organisms under conditions presumed to be constant for them. Her hypothesis was that the organisms in some manner depended upon this environmental periodicity for the maintenance of their persisting regular rhythms, having periods close to solar-day periods.

Temperature and Rhythm

The controversy appeared terminated in favor of Pfeffer's autonomous internal timing hypothesis as a consequence of what was at that time considered to be a crucial experiment. Bünning (*4*), apparently recognizing that both Pfeffer's and Stoppel's hypotheses were equally tenable, reasoned that if an independent internal cycle-timer were involved, then, like living processes quite generally, the timer should be speeded up (the cycles shorter) or slowed down (the cycles longer) in response to changes in the level of constant temperature at which the organisms were maintained. Results of his experiment with beans actually did show change in rhythm-period length with change in temperature, in the expected direction. Bünning found the change in cycle period to be only about 20 percent for a 10° rise in temperature, in contrast to the usual 100- to 200-percent increase for typical biological processes. However, the fact of temperature-dependence of period length was greatly emphasized, since it was interpreted to prove the existence of an independent cycle-timer. Several studies that followed this demonstration by Bünning confirmed his results; all these investigators, too, greatly emphasized this minute influence of temperature level on period length. We now know, as we shall see later, that this experiment, demonstrating slight temperature-dependence, was not a crucial one; its interpretation is ambiguous, supporting equally the two fundamental clock hypotheses. Throughout the 20-year period during which this basic question was considered resolved, there were suggestions that some daily periodicities were fully independent of temperature. Beling (*5*) and Wahl (*6*) appeared to find this true for the daily time sense of bees, and Welsh (*7*), for the rhythmic eye-adaptation in crayfishes.

The whole problem of the relationship of daily rhythmicality to temperature became complicated very early by the discovery by Pfeffer, and the detailed confirmation later by Stern and Bünning (*8*), that temperature changes, like light changes, were highly effective in setting the phase relationships of the labile daily rhythms. Temperature, therefore, was demonstrated to have two possible effects on rhythms, just as it has for certain other biological reactions. One of these is the general kinetic effect, in which the rate of biological reactions is a direct function of temperature level, and the second is the evocation of a specific response to temperature changes as stimuli perceived by organisms.

It was in a climate of contradictions and confusion regarding the relationship of temperature to daily rhythmicality that Webb and I (*9*) conducted in 1948 an extensive study of temperature relations of daily rhythms, using the fiddler crab, an extremely favorable organism for the study of such rhythms. It was established that in this animal the period of the daily cycles of change in skin color was completely independent of temperature over a 20°C range. The physiological and ecological implications of this fact were emphasized. This study marked the beginning of a period during which students of rhythmicality tended to stress the temperature-independent nature of the phenomenon and to de-emphasize the small dependence. As was clearly apparent from the earliest studies of daily periodicities, and especially after it was apparently demonstrated for the time sense of bees, in 1929, temperature-independence is a highly useful characteristic.

Two Rhythmic Centers

The next important advance in our knowledge of rhythm timing involved the demonstration by Webb and me in 1949 (*10*) that the observed daily rhythms of special processes, such as color change, were not the basic timers of the rhythms and that these processes were being regulated by a more fundamental, and relatively more stable, underlying rhythmic component. It was shown that two serially coupled rhythmic centers were involved. A shift in phase of the more superficial, observable rhythm, which could be accomplished by some types of light changes, was found not to be permanent under constant conditions. The phase relationships drifted back, over the course of a few days, to the initial relationships, which were being retained by the unshifted, more stable center. By other kinds of light changes it was possible to shift the phase of the more basic center, a shift which now persisted indefinitely under constant conditions. For example, the more basic center could be phase-shifted through 180°, by two or three cycles of illumination by night and darkness by day, to produce a permanent shift. On the other hand, the more labile center could be phase-shifted to a time 6 hours earlier, relative to the basic center, by alternating 12-hour light-dark (6*L*:6*D*) cycles with the last 6-hour light period occurring between 6 and 12 P.M. in the natural rhythm, or between 6 and 12 A.M. in a previously inverted rhythm.

This last discovery was especially important for two particular reasons: (i) it removed the basic timer from the observed physiological rhythms themselves, and (ii) it clearly indicated that the organism possessed within itself a mechanism for generating regular periods of overt rhythms deviating from 24 hours, since this was obviously occurring during the few days in which the more basic daily rhythmic center was shifting the more labile, observed center back into phase with itself. It is evident for the color-change rhythm that, for a period of about 5 days during which the basic 24-hour center was bringing the more labile center back into phase with itself, the periods of observed change possessed an average period of about 25.2 hours. It was similarly clear that this 25.2-hour period depended continuously upon a rhythm of a different period—24 hours in this instance—for its maintenance.

Later work by Stephens and me (*11*) confirmed and extended this two-center hypothesis of rhythm timing, and quite recent work by Pittendrigh and his associates (*12*) with some other species and processes has reconfirmed the functional separation of a more basic and stable rhythm from the relatively more labile observed rhythms.

The divorcing of the more basic cycle-timer from the observed rhythmic fluctuations of special physiological

processes, and the demonstration that the observed rhythmic periods could deviate at least for several daily cycles from the exact period of the more basic timer, raised, of course, doubt as to what the actual period of the ultimate organismic timing center might be. It also raised some question as to how faithfully the observed physiological periodicities normally reflect the period of such an ultimate timer.

As long as the observed rhythms and the cycle-timers were generally conceded to be one and the same phenomenon, there was clear need for postulating an independent internal clock. However, despite the now widely conceded separation of the basic timer from the observed rhythmic process, Pfeffer's hypothesis of the presence of an autonomous clock is still retained by the majority of investigators and, in fact, the internal clock is considered to exist as the more stable of the two rhythmic centers. This clock is considered to have a period reflected faithfully by the overt rhythms, once they have stabilized their period under constant conditions of light and temperature. This period is termed the "free-running period," and only under special circumstances is it exactly 24 hours. For color change in the fiddler crab, the period appears to be exactly 24 hours, in darkness, through a 20°C temperature range. For most species, it is approximately 24 hours; its deviation from 24 hours is usually a function of the level of constant illumination and temperature. As the prevailing view, it is postulated that the more basic center comprises an independent metabolic "clock system" harboring periodisms that are close to, though seldom exactly the same as, the natural geophysical frequencies. These clocks are presumed to be rather precisely temperature-compensated and to be capable of being experimentally reset to any time of day, or of being made to run slightly faster or slower by suitable adjustment of either the constant light or the constant temperature level.

In brief, it is postulated that the liv-

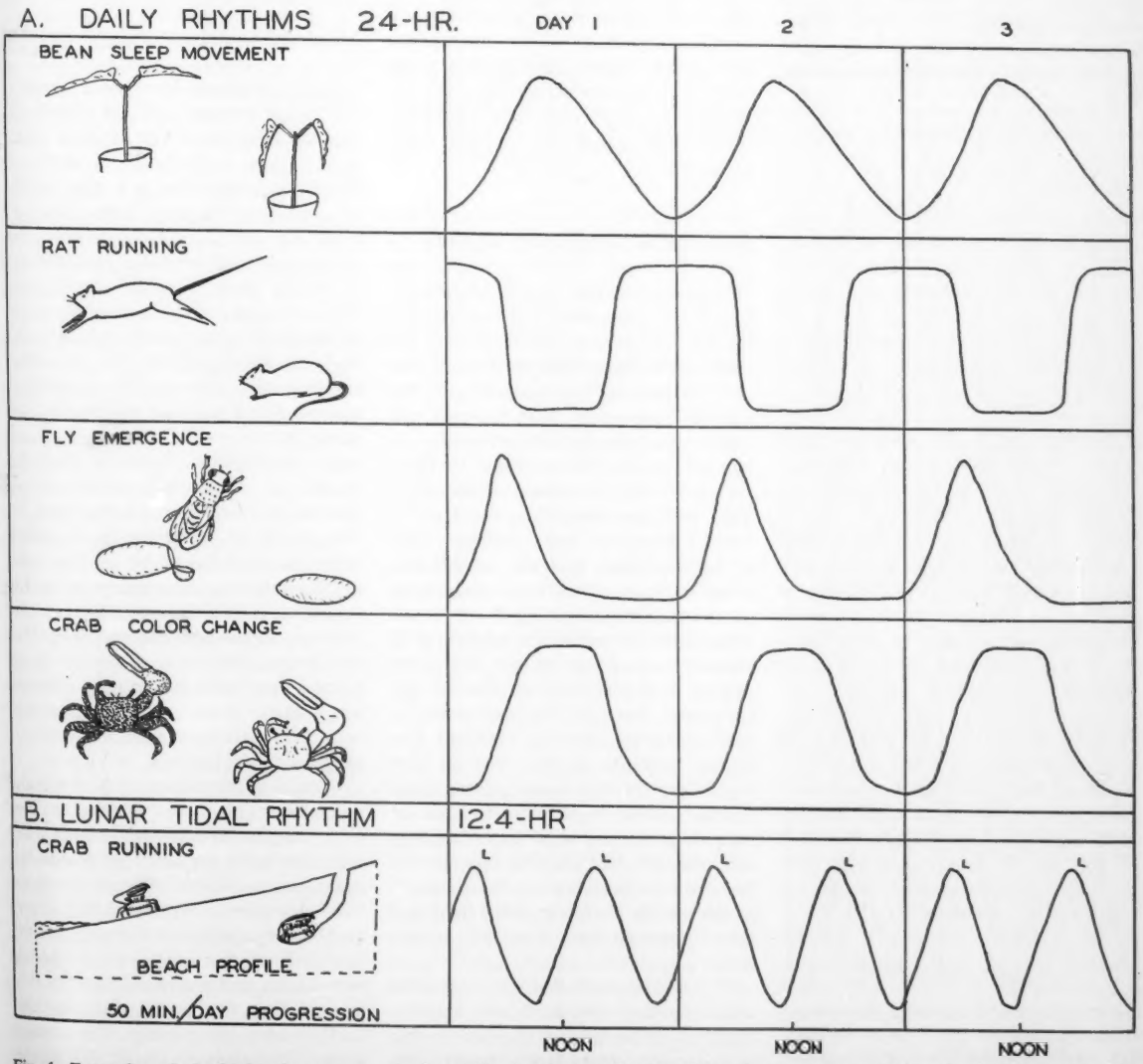

Fig. 1. Examples of rhythmic phenomena experimentally demonstrated to persist under constant conditions in the laboratory, illustrating diagrammatically the natural phase relationships with respect to the external physical cycles. *L*, in the diagram at bottom, indicates time of low tide in the crab's habitat.

ing organism possesses independent, cyclic biochemical systems with inherited natural periods of oscillation. Indeed, it has been shown that, when other factors are equal, period-length in the bean is a characteristic of genetic strain. The periods are presumed to have been derived in the long course of organic evolution under natural selective pressures. The major problems that appear to remain in connection with this hypothesis, are the need for (i) proof that such autonomous clocks actually exist, and if they do, (ii) understanding of the nature of the biochemical mechanisms capable of measuring natural periods even up to a year without any external source of information. In view of an extraordinary immunity of the rhythm period to metabolic poisons, and of the maintained precision of the annual period in dried seeds in the temperature range

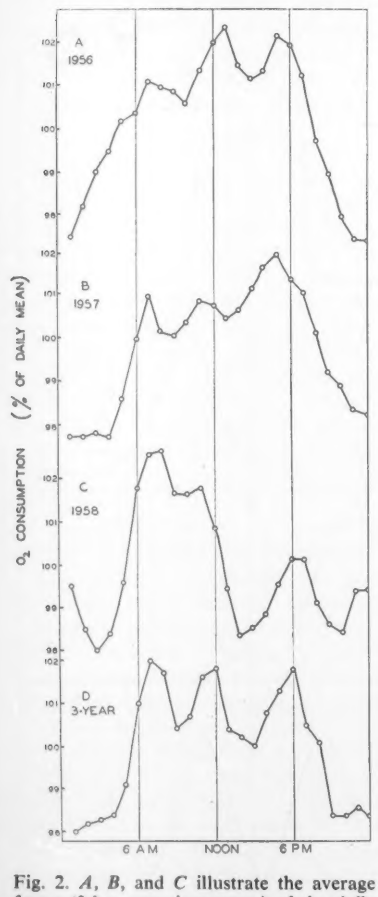

Fig. 2. *A*, *B*, and *C* illustrate the average forms (3-hour moving means) of the daily cycle of O_2 consumption of potato plants under constant conditions during each of three full years of study. *D* is the 3-year mean cycle.

−22° to +45°C (*13*), Bünning has postulated (*14*) that the internal clock must be predominantly a physical, as opposed to a chemical, mechanism. However, every attempt to characterize such a postulated endogenous clock in terms of our current concepts of possible underlying biophysical or biochemical schemes has emphasized the clock's independence of these schemes. In fact, even the site of the clock in the living thing has been similarly most elusive. It seems to be everywhere, and yet nowhere when we try to localize it.

During the past 6 years the rapidly mounting evidence for a most unorthodox, and even an almost incredible, character of any fully autonomous internal clock in terms of our current knowledge of general physiology rendered it advisable to reconsider the working hypothesis of an independent or "closed system" clock. Also, while being by its very nature incapable of proof, the autonomous-clock hypothesis discouraged search for alternative explanations.

Response to Geophysical Rhythms

Supported at this time is an alternative view, proposed long ago by Arrhenius (*15*), as to the nature of the more stable, basic timer for the organismic rhythms of approximately all the natural frequencies. Both rational and experimental support are offered for it, and it is shown how biological rhythms are readily accounted for in these terms. This was also Stoppel's general thesis for the timing of daily rhythms. This is the hypothesis that the clock comprises an "open system" and that timing of the periods persisting in so-called constant conditions is derived through a continuous response of the living organism to its rhythmic geophysical environment. It is postulated that both the observed phase and the observed frequency labilities of the rhythms are expressions of the same phenomenon (phase shifting in response to light or temperature), and that these labilities comprise very nice adaptive mechanisms for normal adjustment of the organism to the specific character of the light and temperature changes occurring in nature.

It was suspected that the organism, under constant conditions, was actually deriving its periods in reaction to the environment, first from reports by Stoppel and others of apparent disturbances in the mechanism in otherwise rhythmic organisms when they were transported to the arctic in summer, or into a salt mine, but especially from an experiment performed with oysters several years ago (*16*). Oysters transported in light-proof containers from their habitat in New Haven harbor to pans of sea water in a photographic darkroom in Evanston, Ill., gradually rephased their rhythm of shell-opening over a 2-week period from the exact lunar-day time of high tide in New Haven harbor to the exact times of lunar zenith and nadir at Evanston, Ill., the theoretical time of high tides in Illinois were there a coastline. This new phase relationship then remained unchanged through a full month during which the study was continued.

Metabolic Cycles

In an attempt to learn more concerning the fundamental basis of organismic rhythmicality there was initiated about 6 years ago a program of study of metabolic fluctuations in a wide variety of organisms ranging from algae to flowering plants, and from invertebrates to vertebrates. Metabolic rate was selected for study, inasmuch as (i) there was no longer a restriction with respect to the kinds of organisms which could be investigated, and (ii) this seemed as fundamental a phenomenon as could be measured and therefore the process that would be the most likely to reflect any basic living-clock rhythms. For the studies an automatic recording respirometer was used in which the metabolic rates could be measured in organisms hermetically sealed under constant conditions, including constant pressure, for several days at a time without any disturbance. It has now become quite clear that under such constant conditions all living things have continually imposed upon them from their environment metabolic rhythms of exactly the natural geophysical frequencies.

Certain of the studies on fiddler crabs and potatoes have been selected to illustrate the general character of the findings; the basic similarity in results for organisms as widely different as these two—a marine invertebrate and a terrestrial flowering plant—emphasizes the fundamental character of the phenomenon. These, and numerous other studies, suggest that the phenomenon is universal among living things. The average form of the daily metabolic fluctuation in the potato for each of three full years, together with the 3-year mean, is illus-

trated in Fig. 2. Despite change in gross form from year to year, this cycle was characterized by a nighttime minimum, an early-morning rapid rise, and a trimodal daytime maximum. Its average for the 3 years involves about a 4-percent increase from midnight to noon, though this percentage is, day-by-day, statistically significantly correlated with the simultaneous, weather-correlated mean daily outdoor air temperature. The correlation was direct for temperatures below 57°F and inverse for higher ones. Just as outdoor air temperature obviously possesses an annual fluctuation, so is there an unambiguous annual rhythm in the amplitude of the daily metabolic cycles (Fig. 3, *B*), with the major maximum in October and a lesser one in April-May, and with the major minimum in February. There is also a highly significant synodic monthly rhythm in the form of the daily cycles (Fig. 3, *A*); the cycles depressed most at new moon and least at third quarter.

The studies with the fiddler crab have been restricted to summer months during the past 6 years. The day-by-day fluctuations can be clearly resolved into two conspicuous rhythmic components, each involving a 30- to 50-percent fluctuation. One component, a solar-day one, possessed a morning maximum and a late afternoon minimum. The second component, equally large, is a superimposed bimodal rhythm of lunar-day frequency, with maxima occurring at lunar zenith and lunar nadir. The simultaneous presence of these two rhythmic frequencies and their particular phase relationships to the external cycles results in a fortnightly recurring series of daily patterns of O_2 consumption. The form of the fluctuation on any day is a function of the temporal relationship of that day to the time of new moon or full moon. In Fig. 4 are compared, as an example, the average daily cycles that Webb and I (*17*) found for six consecutive, corresponding days for the two summers 1956 and 1957. Quite comparable would be two series separated by a fortnight; *A*5 is a day of new moon or full moon. These two metabolic frequencies of the crab are quite precisely the geophysical frequencies and appear to persist indefinitely.

It can readily be demonstrated that the daily metabolic periods in both the crab and the potato are imposed day by day from the external physical environment. One method has been the following: In Fig. 5 are seen (*A*) the mean summer-month (May-August) daily cycles for 3 years for potatoes, (*B*) a

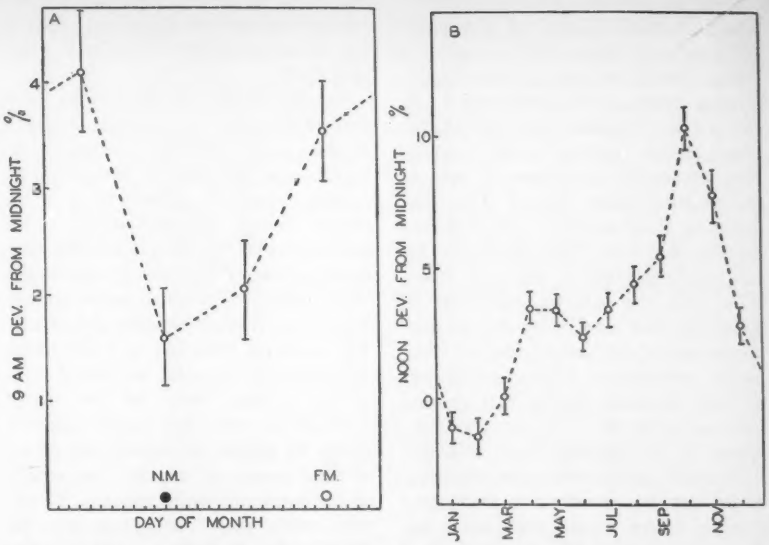

Fig. 3. (*A*) The average percentage increase in O_2 consumption from 1 A.M. to 9 A.M. as a function of four periods centered over each of four quarters of the moon. (*B*) The average percentage increase in O_2 consumption from 1 A.M. to noon as a function of the month of the year during a 3-year continuous study under constant conditions. Standard errors of the means are indicated.

sample summer-month mean daily cycle of barometric pressure, and (*C*) the summer-month mean daily cycle for crabs for 4 years. Far beyond any statistical chance, the 6 A.M. rates of O_2 consumption of both potatoes and crabs are positively correlated with the weather-related deviations in the 2 to 6 A.M. mean rate of pressure change. The higher the rate of morning pressure rise, the greater the 6 A.M. metabolic deviation on that day. The 6 P.M. deviation in metabolism of the potato is negatively correlated with the day-by-day 2 to 6 P.M. rate of pressure change, while in the crab, on the other hand, it is positively correlated. The higher the 2 to 6 P.M. rate of pressure drop on any given day, the lower the 6 P.M. metabolic rate in the crab and the higher the 6 P.M. rate in the potato on that day. Whereas, therefore, both species are deriving daily periods from a pressure-correlated external factor, the potato maintains a high metabolic rate throughout the day by alternating the signs of its 6 A.M. and 6 P.M. correlations. This can be interpreted as an adaptation of the light-dependent plant. The crab, whose adaptive actions are predominantly lunar-tidally regulated, continues with the same sign for both its 6 A.M. and its 6 P.M. correlations. However, the crab appears to possess the capacity to alternate signs like the potato. The bottom curve *D* is the mean daily metabolic cycle for 1 month for crabs whose daily cycles of color change Webb and I (*18*) inverted by several periods of illumination by night and darkness by day. Under these circumstances, for the crab the 6 P.M. correlation in, for example, its phase-labile color-change rhythms, is now the physiological equivalent of the former 6 A.M. correlation. The crab, now, like the potatoes, exhibits a maximum rate where there was formerly a minimum. But, interestingly, it simultaneously retains its 6 A.M. positive correlation with pressure change. Thus it appears that the sign of the correlation with the still unidentified rhythmic external factor is, to some degree at least, under organismic control.

In Fig. 6, *A* illustrates for the potato the regressional relationship of the 6 A.M. deviation in metabolic rate with respect to the rate of concurrent morning pressure change. For the crab, in view of the absence through the day of sign change, *B* illustrates both the 6 A.M. and the 6 P.M. deviations relative to the 2 to 6 A.M. and the 2 to 6 P.M. pressure changes, respectively, plotted in one figure. The latter relationship includes data for about 8 months of four summers (1955–58), reduced to the 30 corresponding days of the synodic month. The over-all correlation, 0.67, is good for a biological one. However, some additional, very exciting, information is found to be present in the correlation when it is carefully analyzed. If one removes five points over each, the

first and third quarter of the moon (fifth to ninth days after new and full moons), when the overt cycles of spontaneous motor activity crest over 6 A.M. and 6 P.M. (compare also Fig. 4), the times of day involved in this correlation, the coefficient jumps at once to the relatively high one of 0.86. The points involved are the +'s for P.M. and the X's for A.M. The coefficient for A.M. alone is 0.62, or for P.M. alone, 0.76. This can only be interpreted as indicating that underlying the weather distortions of the daily cycles of barometric pressure are average parameters of daily pressure change that characterize each day of a fortnight. The crabs appear to be deriving their strikingly reproducible metabolic solar and lunar cycles day by day from a fluctuating external factor whose fluctuations are more independent of the local, weather-related tropospheric turbulences than is the actual, monitored barometric pressure itself.

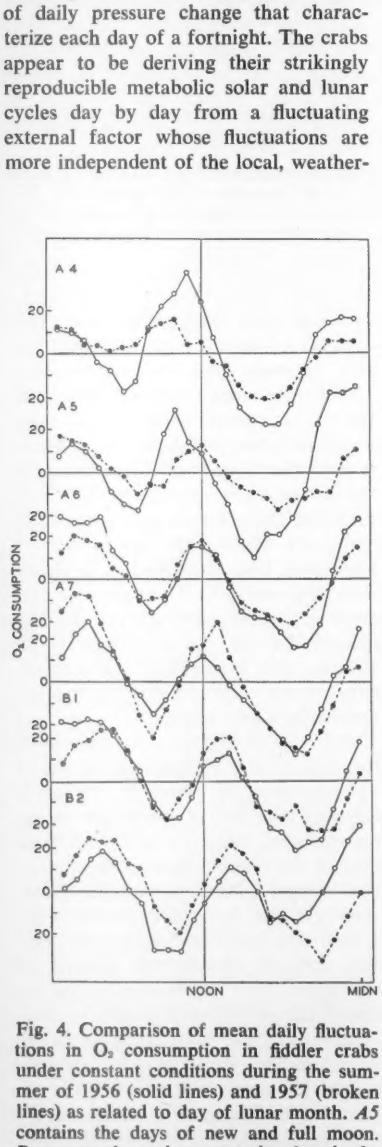

Fig. 4. Comparison of mean daily fluctuations in O_2 consumption in fiddler crabs under constant conditions during the summer of 1956 (solid lines) and 1957 (broken lines) as related to day of lunar month. *A5* contains the days of new and full moon. Represented are six consecutive days in the natural synodic month. The ordinate values are deviations from the daily means, expressed in arbitrary units.

In other words, in response to these barometric-pressure correlates a group of crabs on any given day of the synodic month—for example, the first day after a new moon—is exhibiting a cycle which, though distorted slightly with the weather of that day, is actually very close to that of the average of enough "new moon +1" days to neutralize the day-by-day random weather distortions. The crabs are behaving as if they were responding to the solar and lunar tides of the calmer "seas" of the upper atmosphere, with this accounting for nearly 80 percent of certain parameters of their measured, regular, fortnightly or semilunar metabolic patterns. Therefore, while their metabolism can be shown to be affected to a small but definite extent by the "wind-battered seas" of the weather-ridden troposphere, the major cyclic periods are being relayed as if from a gentle swell of a relatively calm atmospheric "ocean."

The mean daily cycle of barometric pressure also exhibits a conspicuous annual modulation in its form. This is particularly evident in the time of occurrence of the afternoon minimum. This gradually drifts from about 7 P.M. in summer to about 2 P.M. in winter. Consequently there is an annual rhythm, involving even a sign change, in the 2 to 6 P.M. rate of pressure change, a parameter with which metabolism of all living things displays a correlation. Correspondingly, an annual modulation in the form of the daily metabolic cycles in potatoes under constant conditions has been demonstrated (*19*).

It should be emphasized that while exhibiting their pressure correlations the organisms themselves are being maintained under constant pressure, and hence that pressure and the well-known solar and lunar tides of the atmosphere cannot be the immediately effective factor for the organisms. But of tremendous import for the clock problem is the fact that of the several species of plants and animals already studied in our laboratory, all exhibit the same kind of metabolic correlation with the same specific barometric pressure parameters. This has been shown to be true throughout the gamut of living things, from algae to vertebrates.

Another thought-provoking metabolic correlation has been found, that with primary cosmic radiation (*20*). Leading initially to this discovery was the finding that the daily cycles of several organisms in 1954 were in good measure inverted with respect to those of the same species under similar constant conditions in corresponding months of other years in which they had been studied. The first corresponding apparent inversion in a simultaneous geophysical fluctuation was found to be in cosmic radiation, from data generously loaned by J. A. Simpson of the University of Chicago. In Fig. 7, *A* and *B*, it is seen that between the months of July 1954 and July 1955, both the crab and the radiation cycles had essentially inverted, the crab retaining a nice negative correlation with the radiation cycle. For the potato, between the months of May 1954 and May 1955 (*C* and *D* in the figure), the metabolic cycle had in-

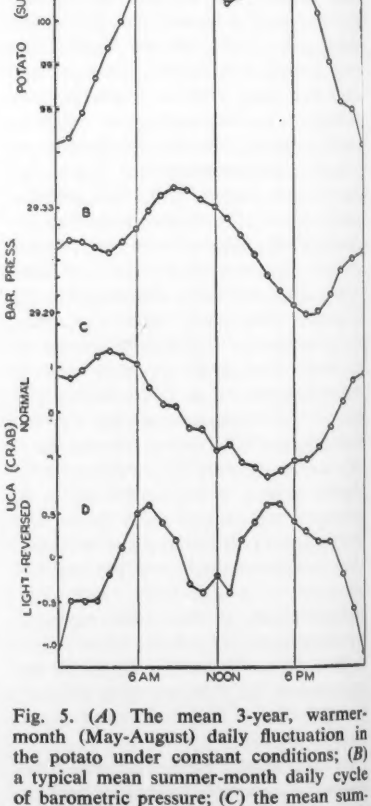

Fig. 5. (*A*) The mean 3-year, warmer-month (May-August) daily fluctuation in the potato under constant conditions; (*B*) a typical mean summer-month daily cycle of barometric pressure; (*C*) the mean summer-month (1955–58) persistent daily cycle of O_2 consumption in the fiddler crab; and (*D*) the mean daily metabolic cycle for a month in crabs whose physiological cycles were shifted 180° by exposure to illumination for a period by night and darkness by day.

verted for the morning hours only, and, correspondingly, so had the cosmic radiation. The correlation with radiation for the afternoon hours was, for the potato, a positive one for both years. It is interesting to note that for both crabs and potatoes, at the time of morning positive correlation with barometric pressure change, the correlation with the cosmic radiation is negative. The crab, which retains throughout the day the same sign of pressure correlation, continued to mirror-image the radiation throughout the day. The potato, which reverses the sign of its pressure correlation between the morning and the afternoon, is seen to have changed the sign of its cosmic-radiation correlation between these portions of the day.

The mean daily metabolic rate of the potatoes, under constant conditions, also displayed a significant synodic monthly rhythm (Fig. 8, *A*), with the minimum shortly after the new moon, and a clear annual rhythm (Fig. 8, *B*), with the minimum in October-November, during three consecutive years of study. The ranges were 10 and 80 percent, respectively.

It is true that, were one dealing only with regular rhythms of solar and lunar daily, monthly, and annual frequencies, it could conceivably be maintained that such rhythmic events as those described here depended solely upon an inherited "internal-clock" complex which independently duplicated the natural geophysical periodicities. But this clearly becomes highly improbable when, as we have just seen, the organism under so-called constant conditions is informing us through its metabolic fluctuations that it is continuously apprised of even hour-by-hour or day-by-day weather-correlated irregularities in the well-known geophysical rhythms of such factors as outdoor air temperature and atmospheric pressure changes. Certainly no autonomous internal clock can be imagined which would provide us with a continuous accurate record, even hour by hour, of the weather-related random irregularities in natural external physical cycles ranging from the day to the year.

In brief, many such results as those described above clearly indicate that precise mean periodisms of all the natural geophysical frequencies are being impressed from without upon the living system, even under conditions constant with respect to all factors generally conceded to influence such systems.

The Primary Clock

Such evidence, therefore, has proven the existence of a third organismic rhythmic component. The rhythmic fluctuations of this component, dissimilar for the two components previously described, are synchronized with and have locked phase relations (either 0° or 180°) with external geophysical rhythms. It is postulated that this component provides the organism with reference cycles for all the natural geophysical frequencies. This obviates the necessity for postulating temperature-independent internal clocks for natural

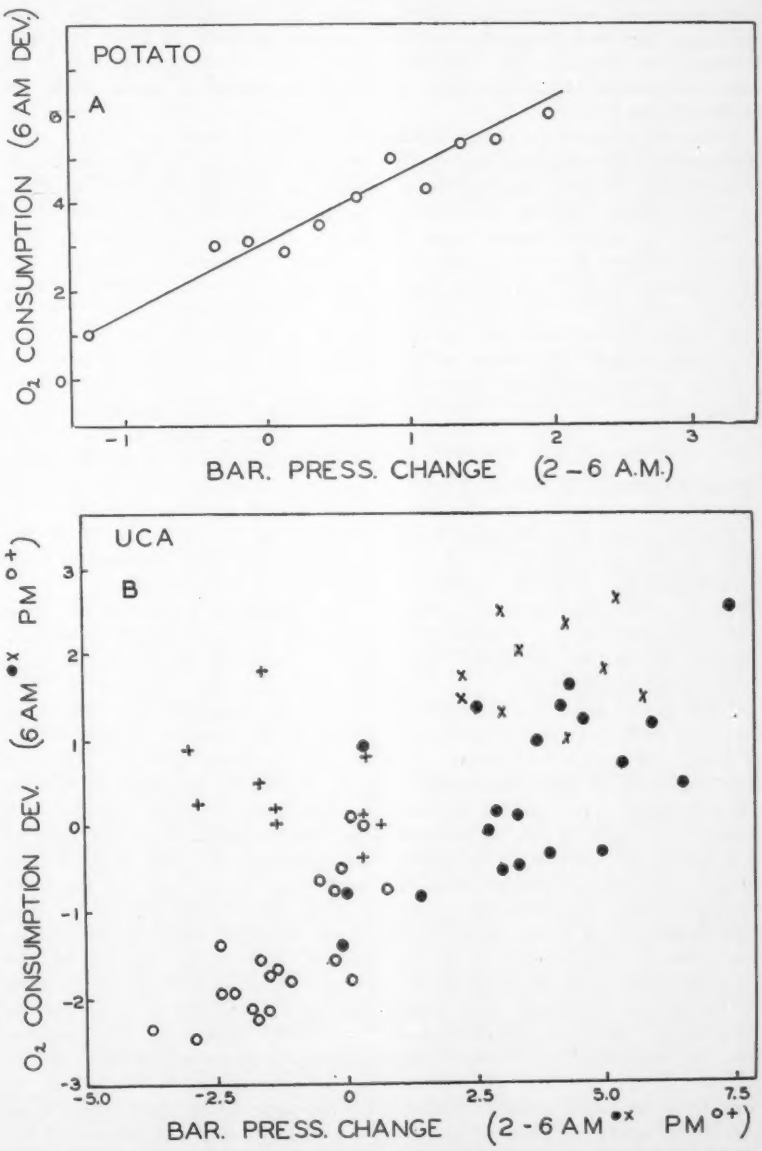

Fig. 6. (*A*) The regressional relationship of the 6 A.M. deviation from daily means in O_2 consumption in the potato, under constant conditions, including constant pressure, relative to the average 2 to 6 A.M. rate of barometric pressure change for the same morning for the warmer months during a 3-year period. (*B*) The regressional relationship of the 6 A.M. and 6 P.M. deviations from daily means in O_2 consumption in the fiddler crab (*Uca* sp.), under constant conditions, relative to the 2 to 6 A.M. and 2 to 6 P.M. mean rates of barometric pressure change, respectively. Data for 4 years, reduced to corresponding days of the synodic month, were used. Symbols + and X are values obtained from the fifth to the ninth days after both the new and the full moon.

periods ranging from the solar day, through the lunar day and month, to the year. It is postulated that this rhythmic component is the primary clock, with the periodicities of the other two organismic rhythmic centers downgraded to secondary and tertiary levels, respectively, and possessing rhythms and periods which are derived ones—derived in reaction between the primary component and environmental factors, including light and temperature. This comprises, in essence, the responder-mediator-indicator (RMI) hypothesis of rhythm timing (*21*).

Just as the timing of the electric clock depends upon a synchronous motor with a continuous 60-cycle electrical input, so, the evidence suggests, the timing of the living clocks depends upon a continuous inflow of cyclic information of the natural cosmic frequencies. Both clocks, furthermore, may be readily reset in their phases relative to the natural cycles without impairment of the capacity to time individual cycles accurately.

Phase Adjustment to External Cycles

The last matter to be discussed bears upon a probable relationship of the environmentally imposed metabolic rhythms to the observed overt phase- and frequency-labile physiological rhythms of special processes, mentioned in the introduction.

It has been known for many years that overt daily cycles in a wide variety of plants and animals kept under constant conditions of light and temperature may deviate from a precise 24-hour period by as much as plus or minus 4 to 6 hours. For example, in the white rat (*22*) there were found spontaneous running cycles of 25.25 hours in a constant illumination of 20 lux, and a 24.0-hour cycle in constant darkness. Upon the initial discovery of this phenomenon by Pfeffer, in connection with sleep movements in beans, it was postulated that this represented a corresponding deviation in the period of an internal clock from the actual solar-day period. In fact, this commonly observed characteristic of daily rhythmicality has been advanced as establishing beyond doubt that the internal clock of the living organism is a fully autonomous one.

This deviation from strict, solar-day frequency has been investigated further in more recent years, and it has been shown that there is a general relationship between the intensity level of the constant illumination, ranging from complete darkness to bright light, and the apparent amount of deviation of the period from 24.0 hours (*23*).

Related to the apparent period length of the daily rhythm is also the level of constant temperature at which organisms are maintained. Usually at some particular temperature, in the normal range for the species, the daily cycles are quite precisely 24 hours in length, but as the constant temperature is adjusted to higher or lower levels, the observed period of the cycle may deviate slightly from the natural daily one as a function of the temperature level. In some species—for example, bean and fruit fly (*4*, *24*)—the period length decreases with increasing temperature; in others—for example, certain algae (*25*)—the periods increase with increasing temperatures. This relation to temperature has been interpreted by most investigators as a consequence of an imperfect temperature compensation of the postulated autonomous internal clock to the kinetic effect of temperature. In fact, this slight temperature-dependence of the apparent cycle period has been considered by many to be additional proof of the existence of a fully independent daily oscillation in living organisms.

An alternative hypothesis for these deviations in cycle length from 24.0 hours, involving autophasing or self-phasing, was first proposed in 1956 (*22*). It was postulated that autophasing would be an expected consequence of the demonstration by Webb (*26*) of a daily rhythm of sensitivity to light as a phase-setting stimulus, together with the demonstration of more detailed characteristics of the phase-shifting mechanism, by me and my associates in 1954 (*27*). It was reported then that all of numerous observed characteristics of experimental shifting of the rhythm phases in color change in crabs seemed best described by a "6- and 18-hour" daily rhythm of crab response to light as a phase-shifting agent. In the normal adaptive phase relationship to the day-night cycles, there appeared to be a midnight-to-6 A.M. portion of the cycle in which the degree of cycle shift to an earlier time of day was a function of the brightness of illumination to which the animal was exposed during this physiological period. The longer portion of the physiological cycle, extending normally from about 6 A.M. to midnight, was one in which the effect of illumination change was to phase the cycle in the opposite direction, to a later time of day. This daily rhythm of alternating directions of response to light in rhythm phasing was interpreted as being nicely adapted to enable the animals to retain optimal phase relationships with the natural light cycles.

Under the hypothesis of autophasing, it is postulated that the organism uses its daily rhythmic fluctuation in sensitivity to light to effect a daily shift in its phase relations relative to its environmentally imposed 24-hour periodicity. The manner of action, in general terms, would be as follows: The organism reaching a "light-sensitive" phase in its daily cycle, and encountering the illumination of a constantly illuminated environment, would be given a shifting stimulus whose strength, within limits, would be a function of the level of the illumination. Though physically the light is held constant, in stimulative effectiveness for the organism it is rhythmic as a consequence of rhythms in the organism's own responsiveness. To use a crude simile, the character of a person's response to a hot stove is essentially independent of whether the person moves to the stove or the stove is moved to the person. Since it has been demonstrated that the

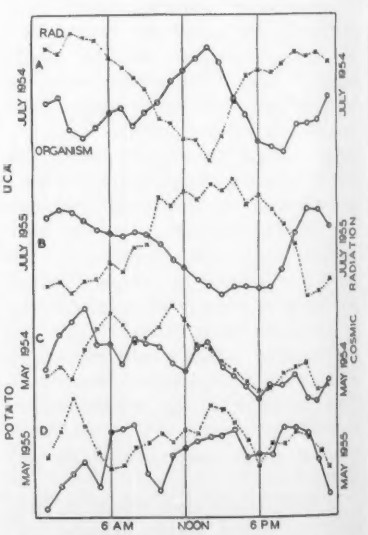

Fig. 7. Comparison of mean daily fluctuations in fiddler crabs (*Uca* sp.) (*A* and *B*, solid lines) and potatoes (*C* and *D*, solid lines) for periods of a month with mean daily fluctuations of the nucleonic component of cosmic radiation (dotted lines) for the corresponding months of the same years.

phase-shifting by light may be in either direction, depending upon the conditions of illumination, autophasing may give rise to cycles that appear to be either longer or shorter than 24 hours. This may depend upon the character of the daily rhythm of sensitivity of the particular species or individual, and hence may be in part genetic. Under conditions in which there is some perceptible daily cycle in illumination, the shifting would be expected to continue until the daily cycle of light sensitivity was optimally adjusted to the light fluctuation, and this is what is always observed. Under constant illumination, since the illumination is equivalent at all hours of the day, the daily cycle would be expected to shift continually, scanning the solar day time after time. This is what is observed in all appropriately investigated instances.

A quite comparable regular day-by-day shifting would be expected in organisms maintained under constant temperature, since Stephens (*28*) has demonstrated a daily rhythm of sensitivity to temperature as a phase-shifting stimulus. As temperature deviates from an organismic optimum for some period of the solar day, autophasing would be expected. Also supporting the view that the reported effects of differing constant-temperature levels really operate through the phasing mechanism is the general fact that the more closely a persistent rhythm frequency approximates a natural geophysical period, the more complete is the temperature independence.

This hypothesis for the explanation of deviations in apparent daily-cycle lengths away from 24 hours is consistent with all the observed facts. It even accounts for the hitherto inexplicable observation that changes in energy levels of both constant visible light and temperature within the normal range effect changes of the same magnitude in observed cycle length. The only demonstrated manner in which these two environmental parameters are essentially equivalent for rhythms is as phasing agents. This is also a most rational hypothesis in terms of expected organismic adaptation to the character of light and temperature fluctuations in nature. This characteristic of the mechanism very nicely enables an organism to maintain quite precise 24-hour periodicity in the natural environment despite large day-to-day changes of a weather-correlated nature in the daily illumination and temperature cycles, or sudden changes effected by the organism's own locomotor movements carrying it during single days to places of differing illumination and temperature in its habitat.

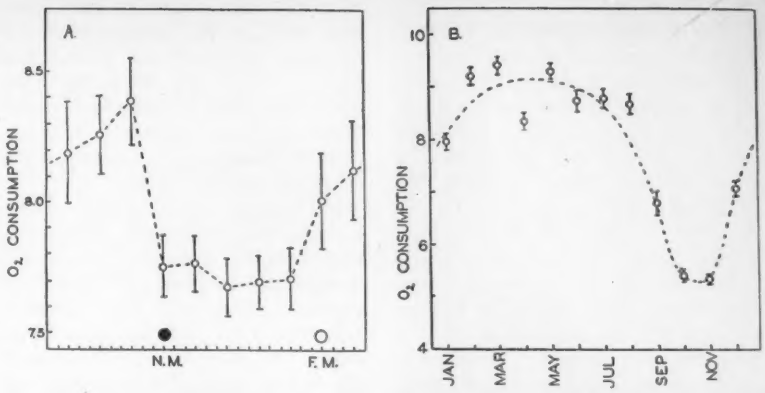

Fig. 8. The mean daily rates of O_2 consumption for 3-day periods through the synodic month (*A*), and for each of the 12 months of the year (*B*), for potatoes under constant conditions, during a continuous 3-year study. Standard errors of means are shown.

Since light changes in nature are, unlike abrupt laboratory light changes, very gradual, the organismic cycles are able to be set adaptively to time of solar day with a higher degree of precision and stability than would be the case were the very slowly changing illumination of a single morning or evening twilight the sole means of phase setting. The organism, as it were, employs a recurring 24-hour pattern of light and temperature "testing" to enable it to move gradually into an optimally adaptive phase relationship with the external light and temperature cycles. The farther the organismic cycle from phase adjustment, the greater the daily shift; the nearer to adjustment, the smaller the daily shift. It is presumed that, once set, the cycle periods in nature are maintained with precise mean 24-hour periodicity by continuous 24-hour periodic testing of the two primary phasing environmental parameters, light and temperature. The relative importance of the two would be expected to vary with species.

There is ample reason to believe that both morning and evening changes in the environmental factors are involved in phasing. Since these work antagonistically to one another, there would be no significant change in phase relations in passing from a clear to an overcast day—a change which might occur were the rhythms phased by some absolute threshold for light at a single time of morning or evening.

In terms of this hypothesis the basic clocks are environmentally regulated and of the precise geophysical periods. The deviations of the observed periods of physiological rhythms under constant light and temperature become, instead of errors in a postulated internal clock, a splendidly adaptive means by which the organism gradually "seeks out" the best fits to prevailing external daily cycles of light and temperature. The use of 24-hour cycles of "environmental testing" is clearly a very nice way for the organism to minimize the effects of physiological adaptation to light and temperature which would doubtless render the very gradual daily changes in these two factors difficult to resolve.

Basic Exogenous Timing

Another interesting property of the persistent daily rhythms may be comparably accounted for by basic exogenous timing. It has been known for about 30 years that the daily rhythms of certain processes, such as sleep movements of plants, would follow artificially lengthened or shortened "days" usually up to about 30 hours (15L:15D) and down to about 18 hours (9L:9D). Beyond these limits, the organism would "break away" from its artificially enforced unnatural periods and revert to its natural daily period. Webb (*26*) found, for example, that with imposed artificial days of 32 hours (16L:16D), the rhythm of color change in crabs displayed an overt 96-hour cycle, the smallest common denominator of the fundamental 24-hour period and the imposed 32-hour periods. In darkness,

the crabs reverted at once to their 24-hour period.

The rhythmic property just described has been interpreted by some investigators as evidence supporting a hypothesis of an inherited, 24-hour oscillatory period in the living organism which could not be strained into periods beyond these observed limits. However, the observation may be accounted for just as simply in terms of the now well-known 24-hour cycles of sensitivity to phasing by light. It is known that after one abrupt phase setting by light-on (or light-off), the organism is sensitive to additional phasing by an opposite abrupt change in illumination only within a restricted range of times following the initial phasing. If the second stimulus occurs either earlier than the limits (that is, if the artificial days are shorter than 18 hours) or later (if the artificial days are longer than 30 hours), the second and immediately succeeding cyclic changes in light fall within periods in the organismic daily rhythm insensitive to phasing by light. Thus, beyond these limits the organism, being unable to phase, would be expected to revert to its fundamental period of 24 hours.

Similarly, the persistence of the natural period of daily and tidal rhythms during rapid east-west transport by airplane can be postulated to be either a consequence of autophasing effected by endogenous aspects of the living-clock system or a result of exogenous timing through a geophysical fluctuation correlated, for example, with atmospheric electrical potential and operating on universal time.

Environmentally Dependent Clock Model

The demonstration that all the natural geophysical periods are being derived from the physical environment by animals and plants even under conditions hitherto presumed to be constant, together with the clear evidence that organisms can use a rhythm of one frequency to derive a rhythm of a different one, eliminates the need for continuing to postulate autonomous internal clocks possessing all the natural periods. Scientificially, such a hypothesis is of a last-resort type, since it is incapable of definitive proof, depending, as it must, exclusively on negative evidence. On the other hand, such an environmentally dependent clock model as that presented here will probably require revisions from time to time as new properties of rhythmicalities come to light. However, short of the demonstration that biological cycles of the natural geophysical periods can still persist in organisms traveling in space well outside of the earth's rhythmic field of influence, there is no logical basis upon which this hypothesis can be rejected.

Furthermore, this hypothesis readily accounts for the hitherto inexplicable immunities of the clocks to temperature changes and to drugs for all natural geophysical frequencies. These last characteristics of the clock are those which are the most unconventional in terms of our current concepts of physiology and biochemistry, and those regarding which no advance in our knowledge of the basic timing mechanism has been made in the half century during which Pfeffer's hypothesis of an autonomous internal clock has been dominant. The present hypothesis reduces the remaining major problems to those upon which, perhaps significantly, most progress has already been made—namely, the mechanism of rhythm phasing, including properties of the coupling systems between the internal rhythmic components, and characteristics of the exogenous information reaching the primary rhythmic component..

In addition, more of the numerous observed properties of the organismic rhythms appear to fall into a consistent framework in terms of this hypothesis than has been the case for any earlier one. This hypothesis also brings, for the first time, the mysterious living clocks out into the open, being far more amenable to investigation and analysis, in terms of our current knowledge in the natural sciences, than earlier "closed system" clock hypotheses. It seems highly desirable to adopt as a working hypothesis a positive, testable approach of this kind.

One of the questions perhaps most frequently asked in reaction to this hypothesis of the nature of the living clocks is the following: How can small imposed metabolic oscillations involving changes of only a few percent be responsible for timing observed biological cycles often involving tremendous energy changes? This, clearly, is no insurmountable problem. In our everyday experience the schedules of railways, airlines, and factories, and even our own daily work patterns, involving relatively huge energy changes, are in fact timed by clocks or watches so low in energy output that a few dust particles may suffice to stop them. The living clock system would appear to be another example of a class of physiological phenomena referred to as triggered responses. It is a common biological experience that there need be no fixed relationship between the energies of the stimulus and the response.

In conclusion, it may readily be seen that all the major evidence that has been marshaled in support of an independent internal clock system with periods of close to, but seldom exactly, 24 hours, can quite rationally be interpreted in terms of organismic natural periods precisely corresponding to geophysical periods, from which all other observed periods are derived through phasing as functions chiefly of light and temperature. And the unequivocal evidence at hand that organisms under so-called constant conditions are, indeed, directly deriving these natural periods renders it highly probable that the ultimate period-giver for all the observed persistent rhythms, from the sidereal day to the year, comprises simply a continuing reaction of the exogenously rhythmic living thing with its fluctuating, physical environment (*29*).

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Environmental Radiation and Cancer

No threshold is demonstrable, and incidence may have rising inflection with intensity.

Harold F. Blum

Although there is no longer room for doubt that ionizing radiation may cause cancer in man (see *1*), any estimate of the potential danger, in this regard, of increase in the level of environmental radiation contains an element of uncertainty. This arises from our lack of information regarding the shape of the curve relating dose rate (incident radiant flux) and the incidence of cancer in the population. Without such information we are forced, in any estimation we may make, tacitly to assume a shape for that curve, and in this we are likely to be influenced by our ideas of the mechanism of carcinogenesis, a matter on which there is not general agreement. The assumption of a linear relationship may be justified as a first approximation, but this does not have experimental or other support. This article is presented with the hope that data relating to another kind of environmental radiation —ultraviolet light—may be of service in this regard.

Induction of Cancer by Ultraviolet Light

"Non-ionizing" radiation in the ultraviolet spectrum induces cancers of the skin of experimental animals with quantitative predictability, the long-wavelength limit for this carcinogenic action lying at about 0.32 μ. Sunlight, having its short-wavelength limit at about 0.29 μ, contains a small fraction of these carcinogenic wavelengths, and evidence converges to indicate that this is a principal cause of cancer of the skin in man. The evidence (reviewed in *2*) includes, besides inferences from the experiments on animals, the fact that skin cancers are largely limited to exposed areas—principally the face—and that there is a correlation with latitude such as might be expected if this radiation were the cause. The carcinogenic wavelengths are the same as those that cause sunburn, and it is probable that there is at least an indirect casual relationship between the two processes. The outer horny layer of the skin acts as a protective filter against the sunburn-producing, carcinogenic, radiation, and this is found to be more opaque for negro than for white skin. Correspondingly, skin cancer is relatively rare in the Negro population as compared to the white.

Cancer induction by ultraviolet radiation has been the subject of a good deal of quantitative experiment, and it would seem reasonable to attempt to apply some of the information gained therefrom to the case of ionizing radiation—lacking as we do the comparable information regarding the latter. I have discussed elsewhere various aspects of carcinogenesis by ultraviolet light (*2*); not all of these aspects will be treated here, but only those that seem to bear directly on the present problem. For this purpose it will be unnecessary to adopt any specific hypothesis for the intimate mechanism, although the quantitative evidence regarding carcinogenesis by ultraviolet light appears to exclude some of those that have been proposed.

A Cumulative Process

Figure 1 presents in a general way a relationship that has been found in these experimental studies (see *2* for a detailed description). The curves show the distribution of cancers within a genetically homogeneous population of albino mice (strain A, males) exposed to ultraviolet light at regular intervals until cancer appears. The curves represent the result of dosages ranging in relative value from 1 to 32, each dose being twice the preceding one. The logarithm of the time required to reach a given percentage incidence of cancer in the population follows a normal distribution, and when different dosages are used the curves move along the abscissa without change in shape or slope; this is not the case if the dosage terminates before the cancers appear. The dosage relationship is described for any percentage incidence level by

$$D t^a / i = \alpha \qquad (1)$$

where D is the dose of ultraviolet radiation delivered at each exposure, i is the interval between these exposures, t is the time to appearance of the cancer (in practice, the time required to reach a volume of approximately 60 mm^3), and α is a constant for the given percentage incidence level. This relationship suggests a continuous, cumulative process —for example, that to be expected for a constantly accelerated growth process. Such a relationship is not easily compatible with the idea of independent periods of induction and growth, nor with abrupt genetic changes, as is implied in the somatic mutation hypothesis (*2*).

Although the doses of ultraviolet radiation were given separately at regular intervals, the dose rate being held constant, the same relationship may be expected to hold if the radiation is given continuously at lower dose rates. In such case we may replace Eq. 1 with

$$I t^a = \beta \qquad (2)$$

where I is the dose rate—that is, the radiant flux per unit time—and β is constant for the particular incidence level. It is seen that the time to appearance of the cancers is proportional to the square root of the dose rate.

But in the present problem we are concerned with the effect of an increase in the dose rate on the percentage incidence of cancer within the population. Let us refer to Fig. 1, where the vertical line labelled L corresponds to 500 days, approximately the normal average lifetime of these mice. It is seen that the incidence of cancers to be expected within the population during this average lifetime is a function of the time to cancer appearance—that is, the period at the end of which a cancer becomes detect-

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able. The same should be true for any other type of cancer in any other population, whether or not the function has the same form as in the present case. From the diagram we see that the dosage corresponding to curve 4 would produce cancer in about 77 percent of the population, the dosage corresponding to curve 2 in about 13 percent, and the dosage corresponding to curve 1, in a fraction of 1 percent too small to express within the dimensions of the diagram. These curves give no evidence of a "threshold" below which cancer is not induced. On the contrary, they indicate that any dosage may induce cancer in some fraction, however small, of the population. Thus, the experimentally determinable lower limit of carcinogenic effect of this agent—and so far as we know, of any other agent—should be a function of the average life-time of the animals concerned and the size of the population studied. Actually, in the case of carcinogenesis by ultraviolet light, there is some evidence of a slight degree of recovery from the carcinogenic process, and so it is possible that a threshold exists at some very low level. But it is, of course, completely infeasible to determine that threshold if it exists. The data also indicate that recovery is a negligible factor—that carcinogenesis by ultraviolet light is a cumulative process and for all practical purposes may be regarded as essentially irreversible and nonthreshold (*2*).

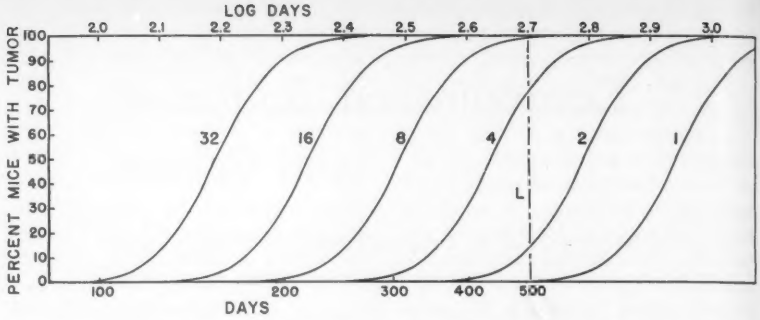

Fig. 1. Percentage incidence versus time to appearance of cancers of the skin of the ears of mice exposed to repeated doses of ultraviolet light, based on experiments described in (*2*). Note that plotting the logarithm of the days to tumor appearance results in a normal distribution of the percentage incidence of tumors. The numbering of the curves indicates relative dosages ranging from 1 to 32, each dose being twice the preceding one. The highest dosage value (32) corresponds to the minimum time observed for a given dosage relationship—that is, when equal doses were given 5 days per week. The vertical line L represents the approximate normal life-time of these mice.

Dose Rate and Percentage Incidence of Cancer

To help in explaining the way in which the percentage incidence of cancer, estimated at the average life-time of the population, varies with dose rate, let us have recourse to the diagram in Fig. 2. Here the curves 1, 2, and 4 of Fig. 1 are represented on a probability grid, which turns the sigmoid percentage curves into straight lines. The units along the ordinate are the commonly used probits, which may be translated directly from percentages by use of an appropriate table. The probit value 5 corresponds to 50-percent incidence, and this may be chosen as the axis. We then write

$$P = \frac{1}{\sigma} [\log t - \log t_5] + 5 \qquad (3)$$

where P is the probit value, read along the ordinate; σ is the standard deviation (the reciprocal of which measures the slope of the curve, and which is constant); and t_5 is the value of t at probit 5.

Rearranging Eq. 2, writing for the specific case of 50-percent incidence (probit 5), and taking logarithms

$$\log t_5 = -\tfrac{1}{2} \log I + \tfrac{1}{2} \log \beta_5 \qquad (4)$$

and substituting in Eq. 3

$$P = \frac{1}{\sigma} [\log t + \tfrac{1}{2} \log I - \tfrac{1}{2} \log \beta_5] + 5 \quad (5)$$

Holding t constant at the value corresponding to the average life-time (L in Fig. 1), and collecting constants as C

$$P = (\tfrac{1}{2}\sigma) \log I + C \qquad (6)$$

Translating the probit values into percentages and plotting in terms of I, instead of log I, we obtain from Eq. 5 the curve shown in Fig. 3. It is seen that at low percentage incidences the slope of this curve becomes steeper with increase in dose rate. That is, the higher the dose rate from which we start, the greater the increment in percentage incidence of cancer within the population with increment in dose rate. At higher incidences (approaching 50 percent) this tendency is reversed.

Relation to Cancer Induction by Ionizing Radiation

Let us picture what this would mean with regard to cancer induction in man by ionizing radiation if the same sort of relationship held. The steady background dose rate of ionizing radiation coming from cosmic rays and radioactivity in the earth's crust cannot be reduced and may be assumed to be the cause of a certain very low incidence of cancer in the human population. If this rate is raised by a given increment, an increase in cancer incidence is to be expected. A second, equal increment of dose rate should result in a greater increment in cancer incidence than that produced by the first one. Successive increments would thus be increasingly dangerous, until a relatively high incidence of cancer had been reached—in-

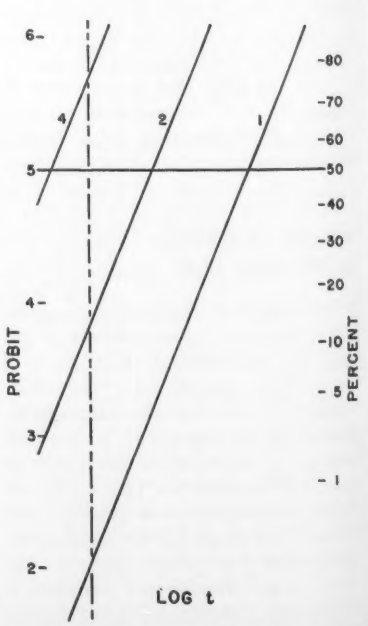

Fig. 2. Curves 1, 2, and 4 of Fig. 1, plotted on a probability grid (probits), which turns them into straight lines.

deed, such incidence as would seem intolerable if the human race is to continue.

A parallel situation should exist in the case of deposition of radioactive strontium in bone, which may cause leukemia and other cancers (*1*). A given amount of Sr^{90} in the bones may be assumed to provide a virtually steady dose rate of ionizing radiation within the body. An added amount of radiostrontium would be expected to raise the dose rate and hence the incidence of cancer; and, again, successive increments would be expected to have increasingly greater effect in the lower incidence range.

But is there any real justification for carrying over the evidence from experiments with non-ionizing radiation? It may be objected that the primary action of these two types of radiation is different, and that, hence, no direct relationship is to be expected. In answer it must be pointed out that the biological effects of these radiations are generally similar, particularly as regards the kinds of quantitative relationships observed, and that we have no evidence to the contrary with regard to cancer. To the best of my knowledge there are no data on experimental carcinogenesis by ionizing radiation that have been obtained in a manner comparable to those with ultraviolet light, nor that will permit a comparable analysis; and until such data have been obtained it seems wisest to accept the parallel. Moreover, carcinogenesis by ultraviolet light has the aspect of a cumulative process, and it seems most likely that the carcinogenic effect of ionizing radiation will turn out to be the same, in which case similar quantitative relationships are to be expected. The normal distribution of cancer incidence found in connection with ultraviolet light appears to be based on the cumulative effect of a number of randomly distributed factors—as may be better appreciated from a more complete analysis of the data and conditions (see *2*). It would not be surprising if the curve relating cancer incidence in man from ionizing radiation did not follow a smooth, normal distribution, as does that found for genetically homogeneous mice exposed to ultraviolet light; the curve might well be skewed in the former case. Nevertheless, any curve resulting from the accumulated effects of a number of randomly distributed factors should have a rising inflection at low incidences, and so the above general analysis should be applicable.

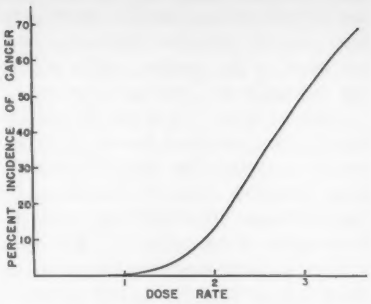

Fig. 3. The effect of dose rate on the percentage incidence of cancer in a population; based on the data illustrated in Figs. 1 and 2.

While much uncertainty must continue to exist, certain things appear clear from the above analysis: There is no definite reason for assuming a threshold for carcinogenesis, and it is infeasible to test the possibility by direct experiment. Thus, there is no justification for assigning a "safe" upper limit for environmental ionizing radiation as regards the genesis of cancer. The assumption of a linear relationship between cancer incidence and dose rate (see *1*) is justifiable only as a tentative first approximation. The curve may be expected to have a rising inflection at low percentage incidences of cancer, in which case estimates based on a linear extrapolation would tend to minimize the effect of increase in dose rate.

It is to be emphasized that what has been said here does not apply to the production of genetic mutations (in the usual sense), which are abrupt, separate events and hence must have a different quantitative relationship to dose rate, but only to the induction of cancer.

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AAAS Chicago Meeting

Raymond L. Taylor

The preparations for any large scientific meeting—even if it is a recurrent yearly event, and one with a basic pattern—are difficult fully to appreciate except by those who have been involved. The annual national meeting of the American Association for the Advancement of Science is particularly complex, uniquely interdisciplinary, and variable with respect to the number and identity of the many participating societies. Typically, all 18 AAAS sections have programs, often symposia one to six sessions in length; some 40 to 50 of the 240 affiliated societies will meet with the Association and sponsor programs varying from single sessions or social events to full-scale national meetings with concurrent sessions extending over four or five days. Several affiliates regularly arrange regional meetings or sponsor special two- or four-session symposia. Another 40 to 50 societies are official cosponsors of the sectional or societal programs of others. Altogether, the AAAS meeting may exceed 300 sessions that range from highly specialized to broad and general ones—arranged, however, so that there is a minimum of conflict for their potential audiences.

The decision of the Board of Directors on the site of the meeting is always made some two to five years in advance. After a survey of the available physical facilities, basic decisions for the meeting and its local committees are made a year ahead. Some of the sectional programs are virtually complete early in the spring, but others, especially those with sessions for contributed papers, are not ready for the printer until early October.

The preliminary announcement of the seventh Chicago meeting [*Science* **129**, 1431 (24 May 1959)] indicated the general scope of this year's con-

vention of the Association. The synopses of the programs, which began to appear in *Science* on 30 Oct. and have appeared in each issue since, have provided additional information, but only the General Program, which should reach advance registrants by first-class mail within the next week, can furnish a full appreciation of the scope and quality of this year's 126th AAAS meeting.

There are events scheduled by the Association as a whole, including two sessions reserved for the AAAS General Symposium, "Moving Frontiers of Science IV," the AAAS Presidential Address and Reception, two meetings of the Council and other business sessions, and the AAAS Smoker for all registrants the final evening. On other evenings there are coffee hours and smokers for the science teachers, for geologists, and for biologists. There are General Sessions sponsored by committees of the Association, a Junior Scientists Assembly especially for science-minded high-school students, and the distinguished evening addresses or lectures sponsored by the Society of the Sigma Xi and the United Chapters of Phi Beta Kappa (jointly), the Tau Beta Pi Association, and the National Geographic Society. Innovations this year include an AAAS-sponsored Popular Lecture especially for interested residents of the Chicago area, and "Dutch treat" social hours following two of the evening events.

The large-scale exhibits of the Annual Exposition of Science and Industry and the programs of the AAAS Science Theatre — both, necessarily, only for registrants—are in themselves worth a trip to Chicago. Optical companies, instrument makers, supply houses, publishers of books, maps, and encyclopedias, and others who provide the tools and supplies scientists and teachers use, collectively, have invested a large sum for the opportunity to meet those who use their products. No one who attends the meetings should fail to visit the more than 90 booths.

An outline of the highlights of the meeting and other pertinent information follows.

AAAS Special Sessions

One of the characteristic and most important features of the annual meetings of the Association is the series of outstanding general addresses by distinguished authorities, sponsored by organizations that meet regularly with the AAAS. These special events are joint sessions with the Association and are open to the general public of the city in which the meeting is held.

Address of the Tau Beta Pi Association; 27 Dec., evening; Donald A. Dahlstrom, president, Tau Beta Pi Association, presiding. John T. Rettaliata, Illinois Institute of Technology, will introduce the speaker; Paul E. Klopsteg, president, American Association for the Advancement of Science, will represent the AAAS. "A New Order of Technological Challenge in the Nation's Space Program," by T. Keith Glennan, National Aeronautics and Space Administration. After the address there will be an informal social hour with a "Dutch treat" bar available.

AAAS Presidential Address: 28 Dec., evening; Paul E. Klopsteg, presiding. "The Development of a Science Policy," by Wallace R. Brode, science adviser, Department of State, and retiring president of the AAAS. Prior to the address Edward L. Ryerson (Inland Steel Company), general chairman of the Chicago meeting, will speak briefly. After the address there will be an informal AAAS presidential reception in the Terrace Casino and adjacent foyer of the Morrison Hotel. All registrants and members of the local committees are cordially invited to attend.

Joint Annual Address of the Society of the Sigma Xi and the United Chapters of Phi Beta Kappa; 29 Dec., evening. "The Adventure of Learning," Lee A. DuBridge, president, California Institute of Technology. Wallace R. Brode, retiring president, will represent the AAAS. After the address there will be an informal social hour with a "Dutch treat" bar available.

Annual Lecture and Film of the National Geographic Society; 30 Dec., evening. "Dzibilchaltun: Lost City of the Maya," E. Wyllys Andrews, Tulane University. Chauncey D. Leake, president-elect, will represent the AAAS.

AAAS General Symposium

At a joint meeting in the spring of 1956, the Committee on AAAS Meetings and the secretaries of the AAAS sections decided that at each AAAS annual meeting there should be one or more general sessions for the Association as a whole. The title "Moving Frontiers of Science" was adopted for these sessions, which consist of reports of research trends and findings of such broad nature that they are of concern to many branches of science.

Part I, 26 Dec., evening. Alan T. Waterman, director, National Science Foundation, will preside. "How Did Life Begin?" Sidney W. Fox, director, Oceanographic Institute, Florida State University; "How Can Artificial Satellites Help Scientific Research?" William H. Pickering, director, Jet Propulsion Laboratory, California Institute of Technology. Part II, 27 Dec., afternoon. Alan T. Waterman will preside. "Genes, Viruses, and Cancer," Wendell M. Stanley, director, Virus Laboratory, University of California; "Elementary Particles of Modern Physics," Robert E. Marshak, chairman, Department of Physics and Astronomy, University of Rochester.

AAAS Conferences

In addition to the Academy Conference, several conferences have become recurrent events at AAAS meetings. These conferences are open to all who are interested. Academy Conference, 27 and 28 Dec.; Conference on Scientific Communication, 29 and 30 Dec.; Conference on Scientific Manpower, 28 Dec.

AAAS General Sessions

Science in the Promotion of Human Welfare. Establishment of the AAAS Committee on Science in the Promotion of Human Welfare was authorized at the Washington Council Meeting of the AAAS in 1958. Members of the committee are: Barry Commoner, chairman; Robert B. Brode; Harrison Brown; T. C. Byerly; Laurence K. Frank; H. Jack Geiger; Frank W. Notestein; Margaret Mead, ex officio.

"Science and Our Future," 27 Dec., morning. Symposium arranged by Barry Commoner, Washington University, who will preside. Speakers: Norbert Wiener, Massachusetts Institute of Technology; Brock Chisholm, formerly director-general, World Health Organization; H. Burr Steinbach, chairman, Department of Zoology, University of Chicago.

Science and Mathematics. The AAAS Cooperative Committee on the Teaching of Science and Mathematics was established in 1941 by representatives of several scientific societies, to work on educational problems whose solution can be obtained better through coopera-

tive action than by any single scientific group working alone.

Session; 27 Dec., evening. Brother G. Nicholas, University of Notre Dame, will preside. "The Extended Science Teaching Improvement Program," John R. Mayor, AAAS. Discussants: F. B. Dutton, Michigan State University; J. A. Brown, University of Delaware; J. R. C. Brown, University of Maryland. "NASDTEC Study of Teacher Certification," William P. Viall, associate director, Washington, D.C. Panel discussion, "A Report on Recommendations for the Preparation of High School Teachers of Science and Mathematics —1959." Participants: Harold E. Wise, University of Nebraska; E. J. McSwain, Northwestern University; Charles E. Olmsted, University of Chicago; Wayne Taylor, Michigan State University.

Session; 30 Dec., afternoon. John R. Mayor, AAAS, presiding. "Secondary School Science Curriculum Studies." Speakers: Malcolm K. Smith, Physical Science Study Committee of Educational Services, Inc.; E. G. Begle, Yale University; Arnold B. Grobman, University of Colorado; Robert L. Heller, University of Minnesota; Robert Silber, Central High School, Evansville, Indiana.

AAAS Popular Lecture

The Committee on AAAS Meetings has felt that each annual meeting of the Association might well include a lecture on a scientific subject, by an eminent authority, especially for the interested citizens of the community. Such lectures, which are regular occurrences at the meetings of the British Association, have occasionally been held under AAAS auspices, but there have been none in recent years. This year's Popular Lecture, sponsored by the Association as a whole, is open to all interested persons on a first-come basis: 29 Dec., evening; George Gaylord Simpson, of the Museum of Comparative Zoology, Harvard University, will lecture on "The World into Which Darwin Led Us." Chauncey D. Leake, College of Medicine, Ohio State University, president-elect of the AAAS, will preside.

AAAS Science Theatre

The AAAS Science Theatre, a permanent feature of the Association's annual meeting, presents each year a selection of the latest domestic and foreign scientific films—throughout the meeting period. Note that, in the following schedule, programs are repeated at different times to increase the opportunities for those attending the sessions of the 126th meeting to see particular films. The Association is greatly indebted to all those who made these pictures and lent them for showing. Admission is restricted to those who wear the AAAS Convention Badge.

Hours of the Science Theatre. 27-29 Dec., 10 A.M. to 6 P.M.. 30 Dec., 10 A.M. to 2 P.M.

Sunday Morning, 27 Dec.

The X-17 Story. Presented by Air Force Film Library Center.

Refining Copper from the Sudbury Nickel Ores. Produced by International Nickel Company, Inc.

The Bottom of the Sea. Produced by Columbia Broadcasting System for "Conquest."

Life of the Molds. Produced by Chas. Pfizer & Co., Inc.

Hospital Sepsis—A Communicable Disease. Produced by American Medical Association, American College of Surgeons, American Hospital Association, and Johnson and Johnson.

People to People. Produced by Interdepartmental Committee on Nutrition for National Defense.

Journey into Spring. Produced by British Transport Service for British Information Service.

The Georges Bank Radar Station (Texas Tower No. 2). Produced by Charles Hegyes for Raymond International and DeLong Corporation.

Sunday Afternoon, 27 Dec.

Solar Flares. Produced by Audio-Visual Education Center in collaboration with McMath-Hulbert Observatory.

Rocket Range Australia. Produced by the Australian Commonwealth Film Unit in conjunction with the Department of Supply.

Dislocations in Graphite. Produced by Atomics International, a division of North American Aviation, Inc., and the United States Atomic Energy Commission.

The World of Microbes. Produced by Tokyo Cinema.

Cancer Cells. Produced by Tokyo Scientific Cinema.

Life Before Birth. Produced by Columbia Broadcasting System for "Conquest."

Fire Ant on Trial. Produced by Agricultural Research Service, United States Department of Agriculture.

Quetico. Produced by Quetico Foundation.

Seven Bridges of Koenigsberg. Produced by Bruce Cornwall Productions.

Tick Paralysis in Man and Animals in North America. Produced by the Rocky Mountain Laboratory of the National Institutes of Health.

Monday Morning, 28 Dec.

Survie du Coeur. Produced by Société Nouvelle Pathé Cinema.

Cave Dwelling Fauna. Produced by Filmtec Production.

Paths of Steel. Produced by United States Steel Corporation.

A Tree is Born. Produced by Forest Service, United States Department of Agriculture.

Oil from Rubber. Produced by Esso Research Corporation.

Water Control. Produced by the Portland Cement Association.

Shock Waves in Schlieren Film. Produced by Shell International.

Warning in the Dark. Produced by Institute for Experimental Psychology, University of Innsbruck, Austria.

Disorders of the Heart Beat. Produced by Churchill-Wexler Film Productions.

Cobalt-60 Radiotherapy of Cancer. Produced by Otto F. Joklik, Transcontinental Atomic Company.

Monday Afternoon, 28 Dec.

Same as Sunday morning, 27 Dec.

Tuesday Morning, 29 Dec.

Same as Sunday afternoon, 27 Dec.

Tuesday Afternoon, 29 Dec.

Same as Monday morning, 28 Dec.

Wednesday, 30 Dec.

The X-17 Story. Presented by Air Force Film Library Center.

Solar Flares. Produced by Audio-Visual Education Center in collaboration with McMath-Hulbert Observatory.

Dislocations in Graphite. Produced by Atomics International, North American Aviation, Inc., and Atomic Energy Commission.

The World of Microbes. Produced by Tokyo Cinema.

Hospital Sepsis — a Communicable Disease. Produced by American Medical Association, American College of Surgeons, American Hospital Association, and Johnson and Johnson.

Life Before Birth. Produced by Co-

lumbia Broadcasting System for "Conquest."

The Bottom of the Sea. Produced by Columbia Broadcasting System for "Conquest."

Quetico. Produced by Quetico Foundation.

Journey into Spring. Produced by British Transport Service for British Information Service.

Other Symposia

Mathematics. "The New Look in Mathematical Education"; "Trends in the Applications of Mathematics"; "Today and Tomorrow in the World of Computers."

Physics. "Recent Advances in Physics" (four sessions).

Chemistry. "Structure and Metabolism of Collagen"; "Some Recent Developments in Organic Chemistry"; "Some Recent Advances in Inorganic and Nuclear Chemistry"; "High Energy Radiation Chemistry of Proteins and Amino Acids."

Astronomy. "The Solar System"; "Astronomical Photoelectric Photometry."

Geology and Geography. "Quantitative Terrain Studies" (three sessions); "Great Lakes Basin" (three sessions); "The Geographer's Role in Transportation Studies"; "Southwest Asia and Northern Africa"; "Economic Changes in Underdeveloped Areas"; "Origin and Development of Limestone Caverns."

Biological Sciences. "Some Unsolved Problems in Biology, 1959: I, Organization of the Cell; II, The Cell in Development and Inheritance"; "The Impact of Electron Microscopy on Biology" (two sessions); "Interactions in Nature: Modern Ecology" (four sessions); "Sand Dune Systems" (two sessions).

Zoological Sciences. "Speciation and Raciation in Cavernicoles" (two sessions); "Invertebrate Classification"; "The Physiology of Reproduction in Birds" (four sessions).

Botanical Sciences. "Classification of Fungus Groups of Debatable Affinity" (two sessions).

Anthropology. "Biology and History in Archaeology"; "Technology as a Backstop to Anthropology and Archaeology" (three sessions).

Psychology. "Verbal Learning and Meaningfulness"; "Unconscious Processes"; "Brain Function and Learning."

Social and Economic Sciences. "World Population and International Relations"; "Scientific Knowledge and Public Policy-making"; "Psychiatry and Criminology"; "Problems in Police Administration"; "Research and Training in Criminology"; "Use of Computers in Simulation of Social Behavior"; "Trends in Family Formation and Structure"; "Descriptive Statistics"; "Statistical Techniques"; "The Pharmacists' Method of Converting to Metrics"; "The Underdeveloped Areas."

History and Philosophy of Science. "Theory Construction in Logical and Historical Perspectives" (two sessions); "Empirical and Conventional Elements in Physical Theory"; "Induction, Probability and Simplicity"; "The Logic of Variables and Constants"; "Philosophical Issues of the Quantum Theory"; "Methodological Problems of Psychology and the Social Sciences"; "The Theory of the Public Interest"; "The Synthesis of Organization."

Engineering. "National and International Aspects of Systems of Units" (four sessions).

Medical Sciences. "Diet, Serum Lipids, Lipid Metabolism, and Atherosclerosis"; "Aging" (four sessions); "Premedical and Predental Education"; "Space Physiology III" (two sessions); "Roots of Behavior: Animal Behavior" (four sessions).

Dentistry. "Oral Aspects of Aging"; "American Dentistry at the Centennial Crossroad."

Pharmacy. "The Scientist's Part in Protection of the Public" (two sessions).

Agriculture. "Germ Plasm Resources in Agriculture: Development and Protection" (five sessions).

Industrial Science. "Science Looks at the Food Industry"; "Management Science."

Education. "Organic and Social Factors in Mental Deficiency and Their Significance to the Educational Program"; "Weapons of the School in the War Against Delinquency"; "Natural History"; "Man and Space Travel"; "Research Symposium"; "How Attitudes Affect Disease Control."

Science in General. "Senior Academy Problems"; "Upper Atmosphere: Solar Relations" (two sessions); "Research in Documentation"; "International Communication in Science"; "Principles of Communication."

AAAS Business Sessions

The Board of Directors of the Association will meet in a private suite in the Morrison Hotel at 11 A.M. Sunday, 27 Dec., and again, at the same hour, on Monday, 28 Dec.

The Council of the Association will meet Sunday afternoon, 27 Dec., at 4 P.M. in the Cotillion room, Morrison Hotel. A second session of the Council is scheduled for Wednesday morning, 30 Dec., at 9 A.M. in the same room. All members of the Council have been notified individually, and it is hoped that all can attend. Subjects to be considered by the Council (in addition to the agenda prepared) usually are first brought before the Board of Directors through the Executive Officer. During the meeting, communications for the Board of Directors should be submitted in writing and left at the Morrison Hotel mail desk, addressed to Dael Wolfle.

There will be a joint luncheon and planning session of all Section Officers and the Committee on AAAS Meetings on Monday, 28 Dec., at 12 noon. Dael Wolfle and Raymond L. Taylor, luncheon cochairmen; Arthur W. Galston, Yale University, committee chairman.

Hotel Headquarters

The Morrison Hotel is the official headquarters of the AAAS; it is where the Council of the Association will meet and where other business sessions will be held. The Press Room—for receipt of author's abstracts and the only source of press releases—is in the Hollywood Room on the mezzanine.

The Main Registration-Information Center, Visible Directory of Registrants, AAAS Office, AAAS Science Theatre, and the Annual Exposition of Science and Industry are all in the Morrison Hotel.

The headquarters of the 18 sections and of the participating societies follow (the societies are grouped in the same sequence as the letters of the sections with which they are affiliated).

Morrison. AAAS; Press; AAAS Committee on Science in the Promotion of Human Welfare; AAAS Cooperative Committee on the Teaching of Science and Mathematics; AAAS Sections A-Mathematics, B-Physics, D-Astronomy, F-Zoological Sciences, G-Botanical Sciences, I-Psychology, N-Medical Sciences, Np-Pharmacy, O-Agriculture, and P-Industrial Science; Association for Computing Machinery, Society for Industrial and Applied Mathematics; American Astronautical Society, American Meteorological Society, Electron Microscope Society of

America, Physics Club of Chicago, Sigma Pi Sigma; American Association of Clinical Chemists; Astronomical League; National Geographic Society; American Society of Zoologists, Society of Systematic Zoology; American Genetic Association, American Institute of Biological Sciences, American Society of Limnology and Oceanography, American Society of Naturalists, Beta Beta Beta Biological Society, Ecological Society of America, Genetics Society of America, Mountain Lake Biological Station, Nature Conservancy, Society of General Physiologists; American Society of Plant Taxonomists, Botanical Society of America, Mycological Society of America; Tau Beta Pi Association, Western Society of Engineers; Alpha Epsilon Delta, American Physiological Society, American Psychiatric Association, Gerontological Society, International Association of Milk and Food Sanitarians; American Association of Colleges of Pharmacy, American College of Apothecaries, American Pharmaceutical Association, Scientific Section, American Society of Hospital Pharmacists, National Association of Boards of Pharmacy; American Dairy Science Association, American Society for Horticultural Science, American Society of Agronomy, American Society of Animal Production, Crop Science Society of America, Gamma Sigma Delta, Poultry Science Association, Society of American Foresters, Soil Science Society of America; Society for Industrial Microbiology, Institute of Management Sciences; American Council on Women in Science; American Geophysical Union; Argonne National Laboratory; Chicago Academy of Sciences; Conference on Scientific Communication; Honor Society of Phi Kappa Phi; International Geophysical Year; National Academy of Sciences; National Association of Science Writers; National Science Foundation; Scientific Research Society of America; Sigma Delta Epsilon; Society of the Sigma Xi; United Chapters of Phi Beta Kappa; U.S. Atomic Energy Commission.

Registration

The AAAS Main Registration-Information Center is located in the lobby of the Morrison Hotel. It will be open as follows: 26 Dec., 27–29 Dec., 8 A.M. to 8 P.M.; 30 Dec., 8 A.M. to 6 P.M.

Badges and General Programs may also be obtained at the supplementary registration desks, but supplementary literature, maps, and the like will be available only at the Main Registration Center. Advance registants (who have received programs and badges prior to the meeting) are urged to visit the Main Registration Center at any convenient time to obtain these items.

Supplementary Registration Desks. For the convenience of those attending the 126th meeting, there are two supplementary hotel registration desks, as follows: Sherman, 26 Dec., 10 A.M. to 9 P.M.; 27–28 Dec., 8 A.M. to 8 P.M., La Salle, 27–28 Dec. 9 A.M. to 8 P.M.; 29 Dec., 9 A.M. to 6 P.M.

Guests at the Hamilton Hotel will find the Morrison convenient for registration. Guests at the Bismark should register at the Sherman.

Registration Fee. The AAAS registration fee, which, intentionally, has been kept at a minimum, is $3; a spouse or child of senior-high-school age not wishing a separate Program, may register for $1, if he registers at the same time as the accompanying regular registrant. Each regular registrant receives a receipt, a Convention Badge, and the General Program—the only publication containing the programs of the 18 AAAS sections and of the 94 participating organizations. Any person who purchases an advance copy of the General Program but does not register in advance and who then attends the meeting has agreed to complete his registration by paying $1—and is expected to do so—at the Main Registration Center, or at one of the two supplementary registration desks, after which he receives his Convention Badge and the privileges that go with it.

AAAS Convention Badge. Every thoughtful person will wish to register and thus pay his share of the expenses of the meeting. The AAAS Convention Badge indicates that you are a complete participant in this 126th convention of the Association. The badge should be worn throughout the meeting because (i) it reminds others to register, and (ii) it is needed for admission to the Annual Exposition of Science and Industry, the AAAS Science Theatre, and the AAAS Smoker, and (iii) it helps your friends to find you.

Visible Directory of Registrants. The Visible Directory of Registrants, for the maximum convenience of all, is located in the foyer near the Annual Exposition of Science and Industry, on the first floor of the Morrison Hotel. It is open at all times. The registration cards of all registrants are placed in the Visible Directory soon after registration. The arrangement is alphabetical. The cards of advance registrants are *completely* alphabetized and typed, since they are posted in Washington prior to the meeting; all other registration cards are filed to the second or third letter of the surname (Ba, Be, and so forth). Members of the press, exhibitor personnel, and guests are included in the Visible Directory—on *blue* cards instead of yellow. Registrants will find the Visible Directory invaluable in determining the convention addresses of friends attending the meeting.

Mail, Telegrams, and Messages. Mail and telegrams addressed in care of the AAAS will be held at the AAAS Office, Parlor E, on the second floor of the Morrison Hotel. Telephone and personal messages will also be filed alphabetically in the AAAS Office, and the names of those for whom they are intended will be posted on a bulletin board near the Visible Directory. The Association assumes no responsibility for the delivery of mail or of telegrams.

Society Meal Function Tickets. Tickets to the dinners or luncheons of any section or any participating society are obtainable only from its representatives, either during preceding sessions, at the AAAS Information Center, or at supplementary Registration Desks.

Local Travel Directions

At this 126th meeting, since the five hotels used are all within two blocks or less of each other, no travel directions are necessary except, perhaps, to reach the points of interest listed below. For these, if necessary, ask at the AAAS Information Center in the Morrison Hotel.

Tours and Points of Interest

At this meeting there will be no formal tours sponsored by the AAAS as a whole, but certain sections and participating societies have planned tours and field trips, as noted in their programs.

Chicago, second largest city of the nation, is justly famous for its downtown skyscrapers, scenic lake shore, and extensive park system. The following are of particular interest.

Adler Planetarium and Astronomical Museum. Lake Front, near the Natural History Museum. Open daily, except Christmas and New Year's, 10 A.M. to

5 P.M.; show nights (Tuesday and Friday) until 9:30 P.M.

Art Institute of Chicago. Michigan Ave. opposite Adams St. Open weekdays 9 A.M to 5 P.M.; Sundays 12 noon to 5 P.M.

Chicago Academy of Sciences. 2001 N. Clark St., in Lincoln Park. Open daily, except Christmas, 10 A.M. to 5 P.M.

Chicago Board of Trade. La Salle St. and Jackson Blvd. Open Monday to Friday, except holidays, 9:30 A.M to 1:15 P.M. Movie every 45 minutes.

Chicago Board of Trade Observatory. La Salle St. and Jackson Blvd. Open daily 9 A.M. to 5 P.M., except Christmas.

Chicago Historical Society. N. Clark St. and W. North Ave. in Lincoln Park. Open Monday through Saturday 9:30 A.M. to 4:30 P.M; Sunday 12:30 P.M. to 5:30 P.M.

Chicago Natural History Museum. E. Roosevelt Rd. and Lake Shore Dr. Open daily 9 A.M. to 5 P.M.

Chicago Zoological Park, Brookfield, Ill. Open daily 10 A.M. to 5 P.M.

Lincoln Park Conservatory. Lincoln Park between W. Webster and W. Fullerton Sts. Open daily 9 A.M. to 5 P.M. No guide service after 3 P.M. or on Saturday, Sunday, and holidays.

Lincoln Park Zoo. Lincoln Park, between W. Webster and W. Fullerton Sts. Open daily 9 A.M. to 5 P.M.

Museum of Science and Industry. E. 57 St. and South Shore Dr. Open daily 9:30 A.M. to 5:30 P.M.; Sunday and holidays, 10 A.M. to 6 P.M. The U.S. Science Exhibits from the International Science Exhibition, Brussels World's Fair 1958, are now on display at the Museum of Science and Industry.

John G. Shedd Aquarium. E. Roosevelt Rd. and Lake Shore Dr. Open daily, except Christmas and New Year's, 10 A.M. to 4 P.M.

University of Chicago Oriental Institute. E. 58 St. and University Ave. Open 10 A.M. to 5 P.M. except Monday and holidays.

AAAS Public Information Service

The necessity for the general public to be kept informed whenever feasible of the results of the scientific research and development which it supports, directly or indirectly, is evident. Organized science and the individual scientist must have the understanding and support of intelligent citizens in all walks of life if they are to contribute effectively to the over-all advance of American democracy. It is, of course, equally important that information for the public concerning advances in science be clearly and accurately disseminated and without sensationalism. Progress in this direction in recent years has been in most instances outstanding, thanks largely to members of the National Association of Science Writers, other accredited science reporters, managing editors of American newspapers, and program managers of radio and television stations.

One of the four objectives of the AAAS is to try to increase public understanding and appreciation of the importance and promise of the methods of science in human progress. For this reason, and to protect authors of papers from being misquoted by the press, the Association maintains a public information service for each of its annual meetings. Sidney S. Negus, Medical College of Virginia, Richmond, has been director of this service for most meetings since 1938.

During the meeting, it is in the interest of accuracy and completeness that science writers frequently wish to discuss various research results with investigators. If you are asked to cooperate in this respect or to participate in a press conference, please do so—not only for your own protection but for the benefit of science in general. Scores of science writers will be covering this great scientific convention from the Press Room in the Morrison Hotel. News stories filed by them will be published and broadcast throughout the world. The assistance of authors in helping to make them accurate is earnestly solicited by the Association.

This year, the AAAS is fortunate in having the continued services of Dr. Negus, and also the services of its Local Committee on Public Information, headed by Allen H. Center, vice president in charge of public relations, Leo Burnett Company, Inc.

Chicago Committees

It would be quite impossible to arrange a large and complex meeting and to carry it through to a conclusion successful in all respects if it were not for the devoted services of many local scientists and other members and friends of the Association. They merit the unstinted appreciation of all who attend. It is noteworthy that Edward L. Ryerson accepted the general chairmanship of the Chicago meeting without delay, appointed the local committees promptly, and has kept in close touch with all phases of this year's meeting.

General Chairman

Edward L. Ryerson, Inland Steel Company.

Committee on Exhibits

William V. Kahler, president, Illinois Bell Telephone Company, *chairman.*

Robert C. Becherer, president, Link-Belt Company.

Joseph L. Block, chairman, Inland Steel Company.

Nelson C. Dezendorf, vice president, Electro-Motive Division, General Motors Corporation.

John W. Evers, president, Commonwealth Edison Company.

Robert S. Ingersoll, president, Borg-Warner Corporation.

Edwin A. Locke, Jr., president, Union Tank Car Company.

Lenox R. Lohr, president, Museum of Science and Industry.

Brooks McCormick, executive vice president, International Harvester Company.

Clair M. Roddewig, president, Association of Western Railways.

Carroll Roseberry, vice president, Westinghouse Electric Company.

Ross D. Siragusa, president, Admiral Corporation.

W. J. Peak, assistant vice president, Illinois Bell Telephone Company, *secretary.*

Committee on Finance

Harry O. Bercher, executive vice president, International Harvester Company, *chairman.*

Other members. Allen Center, chairman of the Committee on Public Information, and all the members of the Committee on Exhibits are serving also on the Committee on Finance.

Committee on Physical Arrangements

James H. Smith, associate superintendent, Chicago Public Schools, *chairman.*

Mrs. Muriel Beuschlein, assistant professor, Department of Biology, Chicago Teachers College.

Raymond M. Cook, dean, Chicago Teachers College.

Miss Lorraine A. DeVoe, curriculum consultant in science, Chicago Public Schools.

George A. DiPrima, curriculum consultant in science, Chicago Public Schools.

Louis J. DiSandro, curriculum consultant in science, Chicago Public Schools.

James P. Fitzwater, director, Division of Visual Education, Chicago Public Schools.

David J. Hefferman, assistant superintendent, Chicago Public Schools.

Philip Lewis, director, Bureau of Instruction Materials, Chicago Public Schools.

Thaddeus J. Lubera, associate superintendent, Chicago Public Schools.

Edward C. Schwachtgen, curriculum consultant in science, Chicago Public Schools.

Hobart H. Sommers, assistant superintendent, Chicago Public Schools, *vice chairman*.

Committee on Public Information

Allen H. Center, vice president in charge of public relations, Leo Burnett Company, Inc., *chairman*.

Miss Effie Alley, science editor, *New Chicago American*.

Frederick J. Ashley, director of public relations, Museum of Science and Industry.

John L. Bach, Public Relations Department, American Medical Association.

Miss Mildred Bruder, director of public relations, Chicago Public Library.

Leo Brown, public relations director, American Medical Association.

Daniel G. Cahill, manager of public relations, Illinois Institute of Technology.

Robert Dressler, program manager, station WNBQ–TV.

A. C. Field, program manager, station WGN–TV.

Tom Foy, news director, station WGN.

Gene Gillette, division news manager, United Press International.

Thelma C. Heatwole, Research Division, Armour and Company.

Herbert Hibnick, public relations, Toni Company.

John Holland, Publicity Department, radio station WIND.

Richard D. Johnson, program manager, radio station WMAQ.

Carl W. Larson, publicity director, University of Chicago.

Jack Laugen, director of information services, Northwestern University.

William A. Logan, director, Bureau of Public Information, American Dental Association.

Dominic Quinn, program director, radio station WIND.

Harold Safford, program director, station WLS.

Arthur J. Snider, science editor, Chicago *Daily News*.

Miss Patricia Hanson, TV station WTTW, director of AAAS radio and television programs.

Beverly J. Smith, Leo Burnett Company, Inc., *secretary*.

Honorary Reception Committee

Edward L. Ryerson, Inland Steel Company, *chairman*.

William E. Adams, secretary, American College of Surgeons.

William J. Beecher, director, Chicago Academy of Sciences.

Robert Bean, director, Chicago Zoological Park.

F. J. L. Blasingame, executive vice president, American Medical Association.

Fred R. Bruce, executive secretary, Western Society of Engineers.

K. L. Burroughs, director, Aeronautical University.

C. C. Caveny, executive dean, University of Illinois, Undergraduate Division.

Walter H. Chute, director, John G. Shedd Aquarium.

Victor Conquest, vice president and general manager, Armour Research Laboratories.

Raymond M. Cook, dean, Chicago Teachers College.

C. R. Crakes, educational consultant, DeVry Technical Institute.

Clifford E. Cregg, director, Chicago Natural History Museum.

Bernard S. Friedman, chairman, Chicago section, American Chemical Society.

H. Close Hesseltine, president elect, Illinois State Medical Society.

Norman Hilberry, director, Argonne National Laboratory.

Paul H. Jeserich, president, American Dental Association.

Robert I. Johnson, acting director, Adler Planetarium and Astronomical Museum.

Lawrence A. Kimpton, chancellor, University of Chicago.

Lenox R. Lohr, president, Museum of Science and Industry.

Herbert E. Longenecker, vice president, University of Illinois Chicago Professional Colleges.

Allan McNab, director of administration, Art Institute of Chicago.

James F. Maguire, president, Loyola University.

John Maxon, director of fine arts, Art Institute of Chicago.

J. Roscoe Miller, president, Northwestern University.

Leslie G. Morey, vice president, Chicago Technical College.

Comerford J. O'Malley, president, De Paul University.

Joseph T. O'Neill, president, Illinois State Medical Society.

R. Marlin Perkins, director, Lincoln Park Zoo.

John T. Rettaliata, president, Illinois Institute of Technology, and president, Western Society of Engineers.

Henry T. Ricketts, chairman, Board of Governors, Institute of Medicine of Chicago.

John J. Sheinin, president, Chicago Medical School.

R. Sargent Shriver, Jr., president, Chicago Board of Education.

Edward J. Sparling, president, Roosevelt University.

George C. Turner, president, Chicago Medical Society.

Benjamin C. Willis, general superintendent of schools, Chicago Board of Education.

Annual Exposition of Science and Industry

The large-scale AAAS Annual Exposition of Science and Industry will be located on the first floor of the Morrison Hotel. The exposition will be open only to registrants. The exhibits are of interest to adult professional scientists and are not intended for young people. Accordingly, admission is restricted to registrants; those younger than senior high school age are not admitted. The hours of the exposition are as follows: 26 Dec., 7 to 10 P.M.; 27–29 Dec., 10 A.M. to 6 P.M.; 30 Dec., 9 A.M. to 5 P.M.

AAAS New Member Service—Science, AAAS Publications

Foyer. Whether or not one is a member of the American Association for the Advancement of Science, every person attending this meeting is cordially invited to visit the AAAS booth for information concerning the Association and its activities. Beyond the satisfaction of strengthening its work for science, for scientists, and for society by one's membership, there are demonstrable personal advantages in joining the Association.

Since its founding in 1848, the Association has admitted to membership not only professional scientists but also other men and women who have a general interest in science, who wish to keep

informed of the progress of science, and who would like to support the high purposes of the one organization that represents *all* science. The New Member Service will be pleased to accommodate those who wish to join as of 1 January. Those already members conveniently can nominate others for membership.

Included in the annual dues of $8.50 (for 1960), each member receives the new, enlarged *Science*—the scientific newsweekly, which has the content of the former *Scientific Monthly* combined with it. Free sample copies will be distributed, and all not familiar with this leading journal of science should visit this booth where symposium volumes and AAAS membership insignia are also on display. Prospective advertisers may obtain sample copies of the magazine and the rate card.

AAAS Traveling Science Libraries

Booth 25. The AAAS administers this experimental loan library program with the financial support of the National Science Foundation to encourage the improvement of science and mathematics instruction, to stimulate the enlargement of the science collections of school libraries, and to interest more young people in choosing science careers. It has two phases: the *Traveling High School Science Library* of 200 titles which has been in circulation since the fall of 1955, and the *Traveling Elementary School Science Library* of 160 books inaugurated in the fall of 1959. The high school program currently serves 1700 schools and the elementary program 800 schools. Both collections will be exhibited and annotated lists of the books will be available. Another feature of the exhibit is the master set of over 400 paperbound science books upon which the popular annotated list, *An Inexpensive Science Library*, has been based, and which stimulates reading by high school students, college undergraduates and nonspecialist adults.

As an aid to schools purchasing science and mathematics books under the provisions of Title III of the National Defense Education Act of 1958, the AAAS has published, with the collaboration of subjectmatter specialists, *The AAAS Science Book List*. This represents the first time a comprehensive recommended list of books for high school and public libraries, prepared by scientists, has been made available and which is rapidly being adopted as a standard by the several states. The list is available at $1 per copy.

Aero Service Corporation

Booth 1. This year's exhibit by the Relief Model Division of Aero Service Corporation will feature the completely new, three-dimensionally formed, 18-inch relief globe. This globe nas been in compilation for over 2 years and is the first full-color, preprinted relief globe ever placed on the map and globe market. In addition, Aero Service will also feature a prototype of their relief model of the moon, as well as the standard Aero relief maps of major countries, continents, and individual states.

American Institute of Biological Sciences

Foyer. The AIBS-sponsored Biological Sciences Curriculum Study, supported by the National Science Foundation, is the outgrowth of the opinion held by many biologists in the United States that life sciences curricula at all levels of instruction should be reviewed in the light of recent technical and scientific advances. The major responsibilities for the BSCS are to design a coordinated and modern curriculum in biology, to recommend an appropriate placement of the science with respect to other courses of study, and to explore the possibility of designing special courses for exceptional students at all levels.

The exhibit illustrates the organizational and operational features of the study group. Brochures and newsletters describing the project in greater detail will be available.

American Optical Company

Booth 44. The Instrument Division of the American Optical Company will show its AO-Baker interference microscope, which will be demonstrated with both shearing and double-focus objectives. Another important aspect of the display will be representative models of the Phasetas and Microstar laboratory microscopes. Outstanding advantages of these microscopes include interchangeable and reversible monocular, binocular, and trinocular bodies; focusable stage with variable Autofocus; wide selection of mechanical stages, including the Micro-Glide stage; Dualcone revolving nosepiece; top-quality optics; choice of built-in base illuminator or standard base with mirror; and durable, dove-gray Epoxy finish. Several Cycloptic stereoscopic microscopes will be shown, together with a remarkable new stereocamera accessory. AO representatives will show how stereophotomicrographs can be made in just four quick steps. The vertical illuminator for the Cycloptic stereoscopic microscope will be on display. Techniques in proper illumination, so necessary to good microscopy, will be demonstrated with the Ortho-Illuminator. AO will also exhibit its new overhead Delineascope and the amazing Technamation process—a revolutionary projection method that adds motion to still transparencies.

Association of American Railroads

Booth 37. An exhibit of railroad research activities will show the electrical pickup, amplifier, and recording equipment used to study the dynamic action of railroad equipment, track, and structure by the measurement of displacement, acceleration, and stress. The measurement of displacement by the double integration of acceleration will be demonstrated and recorded on pen recorders, oscillographs, and oscilloscopes. Visitors may actuate the pickup equipment to produce indications on the recorder or oscilloscope. Literature describing many other railroad research activities will be available.

Association of American University Presses

Booth 51. Each press participating in the exhibit is a separate publishing entity, producing technical, medical, and scholarly books of vital interest. This joint exhibit enables you to see books from a number of the university presses and, if you wish, to order them at the booth. A check list of all the books on display is available.

Basic Books, Inc.

Booth 2. The exhibit of Basic Books, Inc., publishers, features new and recent titles of interest ranging from the behavioral sciences to the natural and physical sciences. Among the authors represented are Brand Blanshard, J. A. V. Butler, George W. Corner, C. D. Darlington, Edward Hutchings, Jr., Ernest Jones, Melanie Klein, P. B. Medawar, Karl Menninger, Gardner Murphy, Karl R. Popper, Jean Rostand, and Niko Tinbergen.

Bell Telephone System

Booths 64, 65, and 66. The Bell Telephone System exhibit will show how through science Bell Telephone services are becoming more abundant, economical, rapid, reliable, and efficient to meet the needs of the nation's expanding

economy. Among the many scientific projects at Bell Telephone Laboratories, the exhibit tells about electronic switching, crystals, semiconductors, and magnetics. The importance of some Bell System developments in the defense of the nation is explained. A demonstration tells about world-wide communications by satellites. On display is an actual model of the Vanguard I satellite which has been circling the earth since 17 March 1958 and is still sending signals from its radio powered by Bell solar batteries.

Biological Research Products

Booth 74. Comparative anatomy is most easily taught with the assistance of high-quality, inexpensive anatomical and fetal specimens derived from cattle, sheep, and hogs. Considerable emphasis is placed on the true comparativeness to human anatomy and the advantages available in better packaging in glass for individual use and attention and for bulk delivery. There are individually packaged items such as eyes, hearts, brains and kidneys and other items for single and double student usage, and there are bulk containers of materials for mass class distributions. The use of the fetal pigs with circulatory systems injected with red and blue latex is demonstrated as the most adaptive specimen for both high schools and colleges. Packaged in polyethylene and with excellent and inexpensive manuals, they represent the lowest cost teaching materials for science, biology, and zoology in these high-cost times. We have the talent to create and the skill to produce.

California Corporation for Biochemical Research

Booth 32. California Corporation for Biochemical Research will have representatives on hand to discuss exciting news about our new products and our expanded carbon-14 program. Literature and aids for biochemical research will be distributed.

Cambridge University Press

Booth 10. Cambridge University Press has long been a leading publisher in the natural and physical sciences—chemistry, physics, mathematics, biology, botany, zoology. It lists among its authors some of the world's most distinguished scientists including Sir Arthur Eddington, Sir James Jeans, George Gamow, Lorth Rutherford, Bertrand Russell, A. N. Whitehead, and Sir Charles Sherrington.

Carolina Biological Supply Company

Booth 92. Carolina Biological Supply Company cordially invites all biologists of AAAS to visit with us in our booth. This year we will exhibit the items which we are listing in our catalog for the first time. These items show new departures or improvements in standard laboratory supplies. On hand will be representatives of our staff to demonstrate and discuss new techniques which are being developed. Registration will be provided for our mailing lists for catalogs and *Carolina Tips*. We welcome this opportunity to become acquainted with you who use our materials.

Central Scientific Company

Booth 80. Central Scientific Company will exhibit new instruments for science teachers and laboratory workers, including new high vacuum pumps, thermocouple and discharge gages for vacuum measurements, a complete line of vacuum couplings and connectors; micro and motor driven lab-jacks; coefficient of resistance apparatus; infinite resistance voltmeter; Brownian movement apparatus; kinetic theory apparatus; transistor demonstrator; microwave optics equipment; the Mitac gyroscope; improved dial-type etched circuit resistance boxes; low-cost interferometer; high voltage generators; up-to-the-minute periodic tables of the elements; atomic models; combination hotplate magnetic stirrers; and other laboratory apparatus.

Coca-Cola Company

Booth 31. Ice-cold Coca-Cola will be served through the courtesy and cooperation of the Coca-Cola Bottling Co. of Chicago, Inc., and the Coca-Cola Company.

Collier's Encyclopedia

Booth 5. On display here is the scholarly written and continuously revised, newest, major, indexed reference set on the market. Attractively illustrated, *Collier's Encyclopedia* features over 4000 pages devoted to contemporary science, mathematics, and allied areas. You will find outstanding articles by topnotch authorities on space satellites, guided missiles, rockets, and atomic science. Also on display is the world-famous collection of scientific and literary writings known as the *Harvard Classics*. In this library of 51 volumes, attractively presented and easy to read, one can peruse the original research of physicist Michael Faraday, chemist von Helmholtz, biologist Louis Pasteur, Bacon, Paré, Harvey, Newton, Jenner, and Darwin. You will also find copies of *Collier's World Atlas* and *Book of Facts*. This is one of the most useful atlases published and most reasonably priced too.

Coulter Electronics, Inc.

Booth 88.

Davis Scientific Instruments

Booth 70. Davis Scientific Instruments is well known to psychologists, particularly those in the experimental and behavorial branches, as a supplier of sturdy, dependable instruments. New equipment for generating programs of events within individual experiments has recently been developed and will be displayed for the first time. This equipment can also be employed in teaching machines for both research and classroom use. Also on display will be the well-known PD-104 food pellet dispenser and the LR-130 liquid pump. This equipment for the "demand" feeding and watering of laboratory rats has become the "standard" with psychologists in experimental animal behavior, but it also has applications in the other biological sciences as well as in the medical sciences.

Denoyer-Geppert Company

Booths 90 and 91. The Denoyer-Geppert Company exhibit will consist of colorful, dissectible models of human anatomy, similar models used in the fields of botany and zoology; some osteological preparations will also be exhibited. The new Denoyer-Geppert Biocraft microscopes will be exhibited for the first time, along with a selection of high-grade microscope slides. The exhibit will include also a display of biological specimens embedded in transparent plastic. The biology department exhibit will be supplemented by an exhibit of geological, geographical, historical, and foreign language maps, atlases, and globes. The globe exhibit will include globes for instruction in geography, astronomy, and mathematics. Wall charts in this field will also be displayed. The exhibit will include also a new and very interesting series of colorful wall charts on atomic theory. This is a line of teaching materials that has been developing steadily since its inception in 1916.

Lester A. Dine Co.

Booth 20. Featuring the new sensational Eastman Kodak Startech camera which is the world's only camera that has been specifically created for closeup photography. This inexpensive camera is designed with an F64 diaphragm opening (this is just like a pin-point for a lens) which means that no previous photographic knowledge is necessary to take amazing color slides or prints with the most amazing depth and clarity. The Startech takes a picture from a subject size of 3 inches square to 3 feet square as simply as a simple box camera. In addition, we will show the latest in projectors and viewers for showing color pictures in a classroom or laboratory.

Educational Testing Service

Booth 8. Tests, testing programs, research, and services for selection, guidance, scholarship competitions, placement, educational evaluation. ETS develops tests for direct sale to qualified users in schools, colleges, business, governmental agencies and professional associations; administers nationwide testing programs; builds programs tailored to special needs; conducts fundamental research in measurement, and provides professional advisory services. Recently entered the field of educational film production. Volume 1, *Horizons of Science*, a new film program for the American schools, will be shown during the convention.

Electro-Motive Division, General Motors Corporation

Booth 34. Electro-Motive Division of General Motors has designed a special exhibit for the AAAS Annual Exposition of Science and Industry in keeping with the scientific nature of the show. The heart of Electro-Motive's exhibit is an operating pocket-sized version of an electronic device used in regular production to automatically segregate stellite and standard engine exhaust valves after final inspection. This device became necessary after the introduction of the new stellite valve which was virtually identical in appearance to the standard valve.

The principle of operation of the device is the thermoelectric effect, in which a heated junction of two dissimilar metals produces an electrical potential that is characteristic of the metals employed and temperature of the junction. In this case a constant-temperature copper probe is used, which when placed in contact with the valve face area, develops voltages which are either positive or negative compared to a constant reference voltage—the polarity depending on whether the face area is stellite or stainless steel. This polarity is then used to determine on which side of a transparent "fence" the valve will go. Each type of valve is packaged only on its own side of the "fence", thus reducing the possibility of mixed packaging. In addition to the working demonstration, a mural background depicts the story of Electro-Motive and its principle products—diesel electric locomotives, electric generating peaking plants for utilities, and diesel-electric power for the oil drilling industry.

Elgeet Optical Company, Inc.

Booth 82. A new line of quality microscopes makes its debut at this year's exposition as the Elgeet Optical Company of Rochester, N.Y., introduces the Elgeet-Olympus microscopes. A full range of models will be on display, comprising both research-type instruments and microscopes designed primarily for instructional application. Elgeet representatives will be in attendance to answer questions and to demonstrate the various features and unique flexibility of the new instruments. Already well established in the optical industry as a leader in the design and manufacture of photographic lenses and related equipment for government and industry, Elgeet welcomes this opportunity to mark its entrance into the field of microscopy and to demonstrate to AAAS members the features which make Elgeet-Olympus microscopes outstanding in design, construction, performance, and value.

Encyclopaedia Britannica

Booth 30. A great new edition of the *Encyclopaedia Britannica*, and its correlated fact finding and technical research services, will be on display at this meeting. To those who may be interested in acquiring *Britannica*, there is available a special exhibit discount. Whether your interest is current or for the future, please visit our booth.

Field Enterprises Educational Corporation

Booth 86. The 1960 edition of the *World Book Encyclopedia* represents a major revision of the 19-volume *World Book* which was reviewed as follows in the *AAAS Science Booklist*: "Excellent for young people, should be in every school library, recommended for home use by children, excellent science coverage. Well-selected bibliographies, which have been graded and annotated. A reading and study guide (volume 19) is an important feature." The 20-volume *World Book* was prepared by more than 2500 leading scholars and authorities. Among the 16 living Nobel prize winners who have contributed to the *World Book* are Glenn T. Seaborg, Harold C. Urey, Selman A. Waksman, and Thomas H. Weller.

Folkways Records & Service Corporation

Booth 87. Phonograph records, film strips, and films that demonstrate and document cultures of many people in relation to social, musical, and literary expression in today's world. Makes for a better understanding of man's aspiration to live in one world. Books and catalogs will also be displayed.

Foringer and Company, Inc.

Booth 24. This year the Foringer exhibit will focus primarily upon equipment and apparatus for educational research and the experimental analysis of human behavior. Of course, our well-established line of animal instrumentation has been refined and expanded, and will be represented by recently developed automatic feeding devices for animals and by data recording equipment. But the current interest in educational problems and their solution finds Foringer and Co. ready with a commercially available teaching machine for display to the scientific public. Certainly those with educational research interests, as well as industrial scientists, will not want to pass up this opportunity to explore possible didactic application in their own fields. Other featured aspects of our exhibit will include a variety of automatic stimulus presentation and response elicitation devices adapted specifically for use with human subjects in medico-psychological evaluation settings and in the experimental analysis of behavior. We solicit special attention to the new Osler-Foringer discrimination device designed to aid work with mentally disturbed children at elementary school level.

General Biological Supply House, Inc. (Turtox Products)

Booths 56 and 57. Members of the staff of the General Biological Supply House will be present to greet its many friends and acquaintances. They will be there to meet you personally to discuss any special problems which you may have. Suggestions or ideas of new prod-

ucts or improvements on the present ones, as well as ways in which we may serve you better, will be gratefully acknowledged. Our exhibit will consist of several new and improved teaching aids for biology. We extend to you a cordial invitation if you wish to visit the Turtox Laboratories while you are in Chicago. Transportation from the AAAS Headquarters—to our laboratories and return—will be arranged.

General Electric Research Laboratory

Booth 11. The Research Laboratory will exhibit items from our basic research program, and several of these will be active demonstrations. Specifically, we will have on display the "tunnel diode." This is a new electronic component which we think will have far-reaching effects on the electronic industry. In addition, we will exhibit samples of Lucalox, a new ceramic. Another part of the exhibit will be the "fuel cell," which generates electricity directly from the union of hydrogen and oxygen. The cell has efficiencies of greater than 60 percent, operates at room temperature, and makes no noise. We will have exhibits on fine-particle magnets, ultrasonics, and the thermionic converter.

Graf-Apsco Company

Booth 58. The functionally designed Graf-Apsco microscopes are displayed. As America's leading microscope repair house, our aim in designing these instruments was to make them as foolproof as possible: the usual points of irritation are missing, and the prices are unbelievably reasonable. If you have any repair or obsolescence problems, bring them to us. We shall be glad to help you regardless of the make of instrument you have. In addition to microscopes, a wide assortment of magnifiers and dissecting instruments will be on display.

Grolier Society, Inc.

Booth 61. The Grolier-Americana booth will feature the current edition of the *Encyclopedia Americana*, the *Book of Popular Science*, and science titles from the list of Franklin Watts, Inc. The *Americana* is a standard, scholarly encyclopedia particularly strong in its coverage of the sciences. The *Book of Popular Science* is the only general-purpose science reference set correlated with the general science curriculum and published expressly for use in the school library and in general science classrooms at the junior and senior high school level. Franklin Watts, Inc., a subsidiary of The Grolier Society, is a principal publisher of children's books and is noted for the *First Book* series. 13 Watts titles are included in the *AAAS Reading List for Elementary Schools*. Also available at the exhibit will be material correlating Grolier's *Book of Knowledge* with the elementary curriculum.

Harper & Brothers

Booth 19. Both trade books and college texts and catalogs will be exhibited. Featured will be the new Harper Science Library of paperback science books in library size. Featured catalogs will be the new *Harper Science Books for Children, Kindergarten through Grade Nine* and *Harper Science Books for Young Adults, Grades 10 through 12*.

D. C. Heath and Company

Booth 38. You have been hearing about the revolutionary high school physics course developed by the Physical Science Study Committee at M.I.T. Ask the Heath representative at Booth 38 about this course. See the preliminary editions of the text and laboratory manuals. Heath will also exhibit elementary, high school, and college science and mathematics texts geared to modern educational trends and practices.

Institute of Public Information

Booth 78. Congeners (fusel oil, aldehydes, acids, etc.) are substances found in all alcoholic beverages that provide the taste, bouquet and color. In large amounts, however, congeners may produce toxic effects. This exhibit presents the results of quantitative chemical analyses of congeners found in six leading types of distilled spirits along with correlated acute oral toxicity studies obtained on rats. Pertinent literature will be available.

International Harvester Company

Booths 62 and 63. International Harvester Company will display industrial applications of radioisotopes to practical problems in manufacturing and engineering. Examples of radioisotopes incorporated into a process as tracers illustrate wear measurement and process evaluation. Applications of radioisotopes as discrete sources of radiation include radiography of production parts, and process gages. Instrumentation includes ratemeters, scalers, portable survey meters, radiation analyzer, scintillation crystal and geiger tube detectors.

Kahl Scientific Instrument Corporation

Booths 67 and 68. A display of laboratory, meteorological, oceanographic and radiation instrumentation featuring: Dekameter, for dielectric constant determinations applicable to qualitative and purity analyses and water content measurements; HF titrimeter, for simplified indication of titration end points and nondestructive pharmaceutical testing; Hygrofix, for determining moisture content of grains; precision thermometers; sand strata samples; specialized glassware, Piche Atmograph, a recording evaporimeter; pollution meter, to record particulate aerosols; recording theodolite, for tracking and printing flight vectors; resolving anemometer, for elapsed time and directional wind speeds; Tetalux, for remote temperature and humidity indications. Bacterial bottom sampler, for sediment samplings (particularly in coliform studies); conductivity meter, for sea water determinations; high-pressure reversing thermometers, for soundings at the bottom of the deepest oceanic trenches; plastic water bottle, for chemical and biological samplings where metallic ions are undesirable; sheathed surface thermometers; two-meter submarine photometer, to indicate light penetration through the water. Dosage calculating slide rule, for radiation characteristics; electrostatic dust precipitator, to obtain planchet collections of aerosols for monitoring; water evaporator, for planchet collection of suspended particles.

Kewaunee Manufacturing Company

Booths 48 and 49. The exhibit will consist of three glove boxes (safety enclosures) designed for a variety of research and production applications. One will be set up as a radiochemistry safety enclosure for working with alpha and weak beta emitters. Another glove box will be set up as a safety enclosure for bacterial and viral research or experimentation. The third glove box will be a special double-sided enclosure for research or production work requiring a controlled atmosphere.

Labline, Inc.

Booth 28. Labline, Inc. will feature several new laboratory products. To be displayed for the first time, will be the new No. 110 test tube incubator, in which specimens incubate under 37° constant temperature, are fully visible, yet remain completely enclosed in the cabinet. Also to be seen will be the new

1960 models of high and low temperature storage cabinets, magnetic stirrers, centrifuges and chromatographic and electrophoresis apparatus. Labline, Inc., manufactures an extensive line of instruments and apparatus for research, clinical, bio-chemical and industrial laboratories. In attendance will be Alexander I. Newman, president, Charles V. Kelly, asst. sales manager, and Robert J. Falk, chief engineer and director of product development.

Arthur S. LaPine and Company

Booth 14. Arthur S. LaPine and Company is exhibiting many new models of laboratory apparatus including: Leybold rotary gas ballast vacuum pumps; Coleman meters; Collectochrom continuous chromatographic apparatus; freeze-dryers; melting point apparatus; flash-evaporators; atom models; clamps; microscope slide boxes; Pumpett safety pipetting device; set-up supports; Multimantles; Hamilton microliter syringes; and other late developments in laboratory equipment.

E. Leitz, Inc.

Booth 15. This exhibit will consist of Leitz universal research microscopes.—Ortholux UAM with the following equipment: plano (flat field) objectives, phase contrast equipment with the Heine condenser, equipment for fluorescence microscopy with HBO 200 high pressure mercury lamp. Universal camera microscope Panphot with xenon lamp and equipment for transmitted as well as reflected light. Medical and laboratory microscopes of modern design with rigid limbs and moving stages. Fluorescence microscopy accessories for same. Leitz microtomes for various applications. High and low power prism binocular magnifiers (for stereoscopic viewing). Stereoscopic microscopes with and without objective rapid changers. Leitz micromanipulator with continuous ratio control.

Link-Belt Company

Booths 76 and 77.

Mettler Instrument Company

Booth 18.

Miles Reproducer Company, Inc.

Booth 4. The new lightweight, miniature, self-powered "Recordall" solves the record-keeping problem of the physician in and out of the office. May be slung from shoulder or records in closed briefcase. No plug-in records as far distant as 60 feet. No wires—and at the same time filters unwanted background interferences such as air-conditioners, typing, traffic. Ideal for office and bedside interviews. Lectures, staff meetings, consultations, hospital rounds, training or nurses, telephone, etc. Optional provision for excluding everything except dictation spoken or whispered close to the mike—very useful in car, plane or operating room. Starts and stops automatically by voice-actuation—eliminating supervision and the recording of silent periods—useful in the operating room and with the telephone. Permanent recordings need no transcribing. Cost as low as 3 cents per hour. Compact belts have a total recording capacity up to 3 hours and 8 hours. Indexed for immediate and accurate location. Identifiable. Fileable, mailable. The featherweight file of 100 belts—constituting the entire cumulative case-history in and out of the office—for that many patients —can be carried in one's pocket. These recordings are acceptable by most judges as evidence as they are tamperproof. Cannot be erased or demagnetized. No other recorder like it in the world.

Mistaire Laboratories

Booth 71.

Monsanto Chemical Company

Booth 13. Monsanto will exhibit still photographs and other materials connected with the CBS-TV network program "Conquest." This is a science documentary program produced by CBS-TV and sponsored by Monsanto. Various subjects are treated in these shows and in the exhibit. Examples are: cancer research, oceanography, tuberculosis treatment, etc. Present at the Monsanto exhibit will be a technician from CBS, who will be there for the purpose of discussing the technicalities of television production. We will also be looking for subject matter for future shows.

C. V. Mosby Company

Booth 9. The C. V. Mosby Company, of St. Louis and New York, for almost sixty years has served as textbook publishers for the medical and biological sciences. Our display of many titles will include such new 1959 releases as Harrison's *Manual of Comparative Anatomy*, Hoskin & Bevelander's *Outline of Histology*—4th edition, Anthony's *Textbook of Anatomy and Physiology*—5th edition, Lemon & Russell's *The Plant Kingdom (A Laboratory Manual)*, Gebhardt & Anderson's *Microbiology*—2nd edition, Francis' *Introduction to Human Anatomy*—3rd edition, Zoethout & Tuttle's *Textbook of Physiology*—13th edition, Braungart's *Laboratory Exercises in Animal Biology*—5th edition, Turner's *Personal and Community Health*—11th edition, and many more.

Muscular Dystrophy Associations of America, Inc.

Booth 72. Help and hope for the dystrophic patient. The exhibit shows the manifestations of muscular dystrophy by means of figure drawings with an accompanying text, as well as the present known treatment for patients with muscular dystrophy. The areas of research sponsored by Muscular Dystrophy Associations of America, Inc., are presented along with a pictorial view of the Institute for Muscle Disease, a major center for research into muscular dystrophy and related neuromuscular diseases. The concept that muscular dystrophy occurs in many species of animals is also presented by means of line drawings.

National Geographic Society

Booths 22 and 23. The exhibit of the National Geographic Society will feature the *National Geographic Magazine* and the *Geographic School Bulletins*. Also on display will be maps, books, pictures, and other special educational materials of the Society. An automatic projector will screen a continuous selection of natural color slides. The slides cover National Geographic field assignments and expeditions and were selected from illustrations by staff photographers of the *National Geographic Magazine*.

National Heart Institute, United States Public Health Service

Booth 46. Cellular physiology of aging: varied expressions of a biological process. This exhibit by Gerontology Branch, National Heart Institute and Baltimore City Hospitals presents the background, present status, and current research on the so-called "age pigments" which accumulate in human brain, heart and other nondividing cells.

The first portion presents the overall effect of the aging process on populations and individuals which was formalized into a law by Benjamin Gompertz in 1823. Part of this section shows the fact that the important causes of death exhibit a similar kinetic behavior. The second portion of the exhibit deals with the occurrence of age pigments and the magnitude of their accumulation, as

a representative change in cellular physiology which may reflect or underlie a portion of the mortality kinetics shown above. Results obtained at the Gerontology Branch are here illustrated. The third portion outlines current research into the nature, i.e., physical and chemical properties, of these pigment particles. Unanswered questions bearing on the above are outlined.

National Science Foundation

Booths 26 and 27. The National Science Foundation, an independent Federal agency, is responsible for promoting scientific progress through: (1) developing and encouraging the pursuit of a national policy for promoting basic research and education in the sciences; (2) initiating and supporting basic scientific research, and appraising the impact of research upon industrial development and upon the general welfare; (3) awarding scholarships and graduate fellowships in the sciences; (4) fostering interchange of scientific information among American and foreign scientists; (5) evaluating scientific research programs undertaken by Federal agencies, and correlating the Foundation's scientific research programs with those undertaken by individuals and by public and private research groups; (6) maintaining a register of scientific and technical personnel and providing a clearinghouse for information covering such personnel in the United States; and (7) initiating and supporting, at the request of the Secretary of Defense, specific scientific research activities connected with national defense matters. The NSF exhibit illustrates operating Foundation programs for carrying out these responsibilities.

National Scientific Personnel Bureau, Inc.

Booth 42. National Scientific Personnel Bureau, Inc., of Washington, D.C., is privileged to extend an invitation to prospective employers and employees to visit Booth 42. NSPB, Inc., is providing an attractive booth, its theme being scientific manpower and industrial science. Staff of NSPB, Inc., will be on hand throughout the convention to welcome, to arrange interviews, to interview, to list employers, to register employees, to meet all who seek the personalized service of a professional organization which specializes in service to scientific and engineering, organizational and institutional personnel; service to industry, college and universities, hospitals, and governments. Brochures will be available. Appointments for interviews are being currently arranged at NSPB, Inc.'s head office: 1029 Vermont Ave., NW, Washington 5, D.C.

National Society for Medical Research

Booths 83 and 84.

New American Library

Booth 12. A special display of the inexpensive Mentor and Signet paperbound books selected by the Traveling Science Teachers for the basic reference collections in their lecture and demonstration program in high schools in many states for the 1959–60 school year. Includes many of the 56 Mentor and Signet titles in the AAAS *An Inexpensive Science Library* for 1959. This AAAS list is a basic book selection guide recommended by the Council of Chief State School Officers, the National Science Teachers Association, and state departments of education for purchase of books under the provisions of the National Defense Education Act.

North American Aviation

Foyer. The exhibit of the Missile Division of North American Aviation, Inc., has a space and advanced weapon system theme. A one-sixth scale model of the Hound Dog missile is on display along with associated color transparencies denoting manufacturing, logistics, and flight test activities. Also on exhibit is a 6-foot moon model which depicts the moon surface and its color gradations. This model was recently shown on a nation-wide telecast on the Dave Garroway Show.

Northern Illinois Gas Company

Booth 36. New science and technology are of major importance to the gas industry in developing its future energy system. This new knowledge is adapted to Northern Illinois Gas Company's operations through the company's research department. Three of the various means by which this is done are illustrated in the exhibit: (1) sponsored research. Example: The Institute of Gas Technology's program on gasification of Illinois coal. This research is directed towards developing a satisfactory supplement for natural gas; (2) adaptation of manufacturers' new technology to solve company problems. Example: Minnesota Mining and Manufacturing Company's device which generates electricity from gas by thermo-electric techniques. This is being adapted for cathodic protection of gas mains. Many other applications of thermo-electrics are being studied and show great promise: (3) research by the company toward solving specific problems. Example: Use of telephone company voice communication facilities with auxiliary equipment to read industrial gas meters daily by dialing a telephone number.

Oak Ridge Institute of Nuclear Studies

Booth 69. A free-standing panel display outlining educational programs administered by ORINS for the U.S. Atomic Energy Commission and the National Science Foundation will be shown. Supplementary information on these programs, which range from the high school to the postdoctoral level, will be available in printed form.

Office of Naval Research

Booth 50. The Office of Naval Research will have an exhibit on oceanographic research. The exhibit will show the four areas of oceanographic research and briefly describe them. Facilities engaged in oceanographic research are listed. Various instruments used for research are illustrated. Included is the bathyscaph Trieste, capable of descending several miles deep into the ocean.

Highlight of the exhibit is a globe showing undersea areas. Included are ocean currents, streams, peaks and valleys. Color slides accompanied by a continuous commentary depict methods of research and various aspects of the ocean presently under study.

Offner Electronics, Inc.

Booth 33. Offner Electronics, Inc., will exhibit a most versatile direct-writing oscillograph assembly. All transistorized, the Type R Dynograph has a maximum sensitivity of one microvolt d-c. and has a frequency response beyond 200 cps, permitting direct writing of action potentials. A single set of amplifiers permits recording of such diverse variables as EEG, strain gages, thermocouples, pressure, etc. Ink, heat, and electric writing may be used interchangeably with curvilinear or rectilinear coordinates. Also to be shown is the Type T transistor portable EEG.

Philosophical Library

Booth 79. The Philosophical Library of New York will feature, among its new publications, *The Future of Science* (Bertrand Russell), *Pictorial History of Philosophy* (Dagobert D. Runes), and *The Story of Chemistry* (Georg Lockemann). In addition, *Dictionary of Aeronautical Engineering, Automation,* and *Cybernetics and Society* will be shown.

Packard Instrument Company, Inc.

Booth 45. The products exhibited are electronic instruments for detection and precise measurement of radioactivity, principally in radioisotope studies for medical and biochemical research. The Tri-Carb liquid scintillation spectrometer is designed specifically for efficiently counting low-energy alpha and beta radiation. Two radioisotopes in double-labeled compounds may be counted simultaneously. The Auto-Gamma spectrometer system counts automatically up to 100 gamma-emitting samples, using a crystal scintillation detector. Components of this system are shown in use as a manual gamma counter. A complete gas-flow counting system is provided by either the windowless flow counter or the Flo-Window counter, with the transistorized scaler. The proportional counting amplifier may be used in this system. The ratio-measuring ultraviolet monitor is shown with the automatic fraction collector, designed for time or drop operation. L. E. Packard and Edward Polic will represent the company.

Professional Tape Co., Inc.

Booth 75. We will display scientifically developed adhesive "Time" standard and Hi-Temp tapes, labels which are completely unaffected by heat or steam, cold or freezing temperatures, acids or alkalies, moisture, or oxidation, and which adhere to any surface. With "Time" autoclave labels with TSI ("Time" sterile indicator), the invisible word *sterile* appears on the label only after the label has been in the autoclave for a complete standard sterilization cycle. "Time" scope labels (microscopic slide labels), pressure-sensitive, represent a complete laboratory service for labeling slides. They are available in two sizes, ⅞ by ⅞ and ⅜ by ⅞ inches, in a thick or thin type, one for pathological use and the other for routine use. They are also available imprinted with school name. The labels resist all conditions in the laboratory, including the water bath, and provide a service not heretofore available. They will also cling, never peeling or falling off, and they conform to legal requirements in most states.

John F. Rider Publisher, Inc.

Booth 43. John F. Rider Publisher, Inc., 116 W. 14 St., New York 11, are publishers of texts and manuals on electricity, electronics, space and nuclear age, and allied sciences.

Raytheon Manufacturing Company

Booth 93.

Science Fair Program

Booth 85. Because the Science Fair Program of the Chicago Public Schools has been so successful in encouraging, stimulating, and furthering the interests of scientifically talented students in advance studies and research, a group of Chicago business organizations decided to "show off" some of the projects completed by Chicago students this past year. Almost 4000 students submitted over 2000 exhibits in the 1959 competition. 214 of these were finalist entries. Several of the award-winning exhibits (in the fields of biology, chemistry, electronics, mathematics, and physics) will be on display. Chicago's youngsters have forged an enviable record in the field of scientific research. Stop by and see the results of their efforts.

Science Library

Booths 52, 53, 54. The Science Library is administered by the AAAS as an additional service to publishers of books, both exhibitors and nonexhibitors. It has become an integral part of each year's Annual Exposition of Science and Industry. In the Science Library, books of all publishers participating are grouped by fields of science —a convenience both to the visitor who is restricting his inspection of books to a single category and to the visitor who wishes to browse. Among the publishers represented in the Science Library are: American Association for the Advancement of Science; Abelard-Schuman Limited; Academic Press, Inc.; Annual Reviews, Inc.; Brown University Press; Cornell University Press; Cranbook Institute of Science; Devin-Adair Co., Inc.; Emerson Books, Inc.; Folkways Records and Service Corp.; Free Press; W. H. Freeman and Company; Grove Press, Inc.; Harcourt, Brace and Company, Inc.; Houghton Mifflin Company; Iowa State University Press; Josiah Macy, Jr. Foundation; M D Publications, Inc.; McGraw-Hill Book Company; University of Michigan Press; New American Library of World Literature, Inc.; W. W. Norton & Company, Inc.; Oxford University Press; Prentice-Hall, Inc.; G. P. Putnam's Sons; Reinhold Publishing Corporation; Charles Scribner's Sons; Ivan Sorvall, Inc.; St Martin's Press; University of Texas Press; Yale University Press; Year Book Publishers, Inc.

Science Materials Center

Booth 3. The Science Materials Center exhibit offers a display of its unique line of science equipment for use by young people in school or at home. Many of the products are designed by scientists and educators in consultation with Hyman Ruchlis, educational director of the Center and former chairman of the New York Federation of Science Teachers. Of particular interest in the display are the exclusive new Pre-Electricity Physics Lab, the Calculo Analog Computer, the Ultraviolet Science Lab, the Brainiac K-30 Computer, the Dynatron, the Motograph Science Charts, and other items. The Science Materials Center is a division of the Library of Science.

Scientific Industries

Booths 40 and 41. The Musser "Copernican" planetarium is a new and revolutionary astronomical development designed for use in universities, colleges, high schools, museums, government training institutions, naval vessels' navigation systems, missile and space research establishments, and television studios. Conceived as an IGY project in 1956, the planetarium is making its debut at the AAAS meeting as an educational aid in the new space programs. One of the most important features of the "Copernican" is its electromechanical computer ephemeris which provides virtually instantaneous accurate placement of all the planetary bodies at any given time in thousands of years. The breadth of its teaching value in the field of astronomy includes such features as: star field overlays for various latitudes: direct motion and retrograde star maps in sidereal and civil times; method for finding horizon coordinates; geocentric sky reference overlays; overlays showing P.Z.S. triangles and Sumner lines of position on geocentric earth or sky; system for teaching pertubation theory in satellite orbits, tides, causes of diurnal inequalities, and so forth.

Special overlays show earth-moon gravitational field potential for demonstrating orbits of satellites, Keplerian laws, and so on. The "Copernican" shows the actual movement of all the planets, moon, and asteroids and conversely the stars, galaxies, and constellations of outer space. Ultraviolet light is employed in the sky-simulation of "outer space", and internal light units are motor-actuated for the planets, asteroids, satellites and comets.

Sigma Press of Medical and Technical Summaries, Inc.

Booth 47. Sigma Press is the publishing division of Medical and Technical Summaries, Inc., a firm devoted to research and development of educational aids and publications for higher education and the professions. The company is especially known for its pioneering in the development of new, pedagogically approved reviews in the basic medical sciences. The parent firm is comprised of educators and scientists from the universities and government and private research concerns in the greater Washington area. Along with its research organization, the company maintains complete technical composition and editorial facilities and provides services for the entire publishing operation, including promotion and distribution. The display at the AAAS Exposition is designed to convey the educationally oriented cause of the company to its fellow scientists, and will demonstrate its innovations in products and production techniques. Included will be reports of its summer fellowship program for technical writers and editorial research assistants.

Ivan Sorvall, Inc.

Booth 73. Ivan Sorvall, Inc., will have on display a number of completely new Servall centrifuge developments, some of which are right in line with the modern trend toward automation. Shown in operation will be the Szent-Gyorgyi and Blum eight-tube continuous-flow centrifuge for uninterrupted processing of large quantities of solution at high speeds. Also, the type SS-3 push-button Superspeed (the first automatic unit in its range), the enclosed type SS-4 Superspeed, the new RC-2 Servall automatic Superspeed refrigerated centrifuge—all these of unmatched versatility; a new large capacity type GSA high-speed rotor, and several completely new rotor developments, including the "Sharp" particle-counting rotor and a field-aligning, swinging bucket rotor. Also on display will be the well-known smaller Servall table model centrifuges; the Servall Omni-Mixer with a micro-attachment; and the improved Servall "Porter-Blum" microtome.

Special Libraries Association, Illinois Chapter

Booth 55. The Special Libraries Association booth features a display of translation materials from the SLA Translation Center, the Office of Technical Services, and some of the work of various commercial translation agencies and societies engaged in translation activities. The booth will be manned with librarians who are prepared to answer your questions regarding translations and related activities. There will also be a display of SLA publications and informational brochures regarding various services offered by the Special Libraries Association. Assistance will be given those who wish to inquire about SLA and its program, who are interested in the details of starting a special library, or who are interested in librarianship as a profession.

Spitz Laboratories, Inc.

Booth 60. Through the many-faceted eyes of the Spitz planetarium, school systems in almost 200 communities now provide a singular experience in which both youngsters and adults can acquire the basic understanding of the sky and earth sciences so important to today's expanding curriculum. The standard model Spitz planetarium with its 24-ft Fiberglas projection dome has been specially designed to create a teaching situation where space and time become tools of the instructor. Basic astronomy, geography, history, mathematics, and the humanities are all enriched by the planetarium presentation. The experience is three-dimensional and curved—the illusion is superb; reaction and retention are splendid. All school systems using the Spitz planetarium have also created an excellent public relations asset of inestimable educational value to neighboring communities. Spitz Laboratories of Yorklyn, Del., pioneers in this fascinating field, offers its services and experience wherever a planetarium is being planned.

Tobacco Industry Research Committee

Booth 39. Information about the nature and extent of the scientific research program developed and directed by the Scientific Advisory Board to the Tobacco Industry Research Committee. The research program, covering all phases of tobacco use and health, contains three main areas of investigation within which are the specific fields of research. These areas and specific fields are described. Grants-in-aid have been awarded to 75 scientists in 50 institutions, and recipients have published more than 75 papers in medical and scientific journals.

Henry Turkel

Booth 16. An exhibit of the data from the treatment by medication of 60 mongoloids is presented to demonstrate that progressive normalization of the mongoloid through an individualized course of medication is now possible. Along with the alteration over time of characteristic physical abnormalities and body dysfunctions, the treated patient becomes increasingly receptive to learning and enlarges his range of interaction with the environment. An anatomical classification of mongoloids is utilized as a basis for a rational combination of drugs whose administration is adaptable to standard office procedures of the physician. The goal of progressive normalization of the mongoloid is effected through a combination of drugs whose synergistic action tends to eliminate the fetal legacy of physiological dysfunctions of the body in which the abnormalities characteristic of mongolism have their origin. The theory and detail of the course of medication, the individual drugs, dosage levels and duration of treatment, as well as regressions of improvements as result of withheld medication are shown by means of photographs, x-rays and other records. The data provide ground for abandonment of the fatalistic view, now dominant, that nothing can be done to improve the mongoloid.

Union Tank Car Company

Booth 7. The world's largest circular building without internal supports is displayed in model form. Built to a scale of ⅛ inch to 1 foot, the model of the Union Dome represents the type of modern repair and maintenance facilities the company now has in operation in Baton Rouge, La., and is building in Wood River, Ill. The company, which owns and operates the nation's largest fleet of railway tank cars, has attracted world-wide attention as the pioneer in the construction of large buildings utilizing the geodesic principle of design. This all-steel dome has a diameter of 384 feet and rises to a height of 120 feet. It has a floor area of 110,000 square feet with no hindering internal supports. An indication of the simplicity of the dome is the bill of materials which calls for only three basic items: (i) the hexagonal steel panels, (ii) 6-inch diameter steel pipe used to interlock the vertices of the adjoining panels; and (iii) small half-spheres used to anchor the 6-inch pipes at the base of the dome

to the foundation ring. Graver Tank & Mfg. Co. Division—Union Tank Car Company, engineered, fabricated, and is constructing the Wood River dome and is offering similar services on a commercial basis.

Universal Scientific Company, Inc.

Booth 81. Universal Scientific Company, Inc., Vincennes, Ind., represented by educational director, Joseph E. Vargo, is displaying its electrical and electronics educational equipment used in science studies. This equipment will be demonstrated continuously in our booth, showing how the instructor can convey complex electrodynamic phenomena expediently to students; also will be shown how students are inspired into creative thinking. With this equipment students may study at their respective speeds, and progress of the more talented students is not impaired by the less interested students.

University of Michigan Press

Booth 59. The Ann Arbor Science Library, now containing ten books, with many more in preparation, will be featured by the University of Michigan Press. The books in this outstanding series are written by top scientists, each of whom deals concisely with a sharply defined subject in his special field and addresses himself to the bright student, the educated layman, and the scientist who wants to grasp a subject outside his own field of research. *Mirabile dictu!* popular science that is not "written down." Revised editions of such standard books as Frederick K. Sparrow's *Aquatic Mycophycetes* will be displayed, along with Michigan's staple science titles still used in their present editions. Sydney Chapman's *IGY: Year of Discovery* and Alexander Smith's *Mushroom Hunter's Field Guide* will especially appeal to browsers for their pictorial quality. Michigan's complete catalogs, seasonal announcements, and illustrated circulars will be distributed at the booth. A representative will be on hand to answer questions, accept orders, and discuss publishing projects.

Ward's Natural Science Establishment, Inc.

Booth 29. Ward's Natural Science Establishment cordially invites participants in the AAAS Convention to visit its booth in the commercial exhibits. Ward's presents for your consideration a selection of materials for earth science teaching programs and biology. Both specimen material and equipment is represented. Members of Ward's staff on duty at the booth will be glad to answer questions or to discuss with you any requirements you may have regarding natural science materials for teaching, research, or field work. As the foremost supplier of geology teaching materials, Ward's would especially appreciate receiving visits from earth science teachers, and discussing with them their needs and requirements in geological teaching aids. Ward's Geology Division offers teaching and reference collections, rock, mineral, and fossil specimens, and laboratory and field equipment to meet nearly every need.

W. M. Welch Manufacturing Company

Booth 6. The W. M. Welch Manufacturing Company plans to display selected apparatus used in the physics, chemistry, and biology laboratories. These will include those especially adapted to the teaching of science in the secondary schools and colleges as well as some items specifically designed for special use in research and industrial laboratories. A partial list includes stainless steel balances, quick operating high vacuum pumps, electrical measuring instruments, electronics teaching devices, Densichron for measuring optical density, color saturation, paper chromatograms, etc. Many charts and other visual aids for teaching science, mathematics and physiology as well as preserved specimens, synthetic skeletons and other biological models will be shown.

Westinghouse Electric Corporation

Booth 89.

John Wiley & Sons, Inc.

Booth 21. John Wiley & Sons, Inc., is happy to be at the Exposition of Science and Industry once again. We await the pleasure of your company at our booth, where we will display a wide selection of our college- and professional-level technical and scientific publications. We hope you will drop by for a few moments of browsing and a pleasant chat.

Wilmot-Castle Company

Booth 17. Two new forms of gaseous sterilization, and a new and revolutionary distillation process will be displayed. The Castle Sterile-Aqua system offers a simple, efficient, and rapid method of converting ordinary boiler steam into pyrogen-free water of exceptional quality. All secondary heating is eliminated, with significant savings in distillate cost. The equipment requires only about one-fifth the space of conventional distillation equipment, and is virtually service-free. A 12 gallon per hour still will be shown. An important new advance in the field of area sterilization will also be presented. The sterilant is intended for rapid sterilization of large surface areas. Castle Beta-Propiolactone equipment sterilizes and allows re-entry within a few hours. The new automatic Sterox-O-Matic gas sterilizing equipment, designed for the low-temperature steriiization, will also be shown.

Zenith Radio Corporation and Subsidiaries

Booth 35. Zenith Radio Corporation —Chicago shows a low-noise electron beam parametric amplifier in operation. This is a vacuum tube which achieves stable broad-band amplification at ultra-high frequencies with an extremely low noise level. The new amplifier is used to demonstrate the drop in Johnson noise which results when a small resistor is cooled from room temperature to liquid nitrogen temperature. Rauland Corporation — Chicago shows various special purpose cathode ray tubes including scan converter storage tubes, image intensifiers and high resolution-high brightness display tubes. One example of the last-named type is a 21-ince round tube capable of a minimum resolution of 1000 lines at a light output of 300 to 500 foot-lamberts.

Zenith Radio Research Corporation—Redwood City, Calif., exhibits views of its microsecond flash x-ray equipment, as well as x-ray pictures taken at one-fifth microsecond with approximately 100 megawatts instantaneous power. A new modulator avoids the damaging low-voltage tail of the current transient, lengthening the life of the discharge tube by several times.

Science in the News

United States and Soviet Union Agree to Reciprocal Exchange in Peaceful Uses of Atomic Energy

V. S. Emelyanov, head of the U.S.S.R. Main Administration for Utilization of Atomic Energy, and John A. McCone, chairman of the U.S. Atomic Energy Commission, have signed a memorandum providing for a program of reciprocal exchange in the field of the peaceful uses of atomic energy between their respective countries. The memorandum will be included as an addendum to the U.S.–U.S.S.R. Scientific, Technical, Educational, and Cultural Exchange Agreement for 1960–61. The new atomic energy plan makes general provision for reciprocal exchanges of unclassified information, for visits of scientists to unclassified areas, and for exploration of the desirability of joint sponsorship of unclassified projects.

In order that the International Atomic Energy Agency and its interested members may benefit to the fullest extent from this effort toward further development of the peaceful uses of the atom, the agency will be given all reports and all results of the exchanges. The agency will be asked to assist, to the extent possible, in the consideration of possible joint projects by sponsoring meetings, symposia, or studies considered necessary for such planning.

Emelyanov and McCone have discussed unclassified exchanges in the fields of controlled thermonuclear research, basic research in nuclear physics (including high-energy physics), and civilian power reactor technology. Such exchanges in these and other areas will be proposed in specific detail under the general agreement reached by the two governments. The groundwork for the exchanges was laid in preliminary discussions between Emelyanov and McCone during the visit of Premier Khrushchev in September, during the tour of U.S.S.R. atomic energy establishments in October by McCone and a group of U.S. scientists, and during the recently completed tour of U.S. installations by Emelyanov and a group of Soviet scientists.

The text of the memorandum that has just been signed (except for the introduction) follows. The exchange arrangements described are subject to termination on 30 days' notice by either party.

Exchange of Visits

"For the purpose of exchanging information on further scientific and technical development on peaceful uses of atomic energy in their respective countries, the parties agree to the following exchanges of visits of specialized personnel composed of groups of three to five persons for periods of ten to fifteen days on an agreed and reciprocal basis.

"1. Delegations of scientists specializing in the field of thermonuclear research for visits primarily to the Princeton Project of the USA and the Institute of Atomic Energy of the Academy of Sciences of the USSR, but including short visits to additional facilities engaged in thermonuclear research in the USA and the USSR.

"2. Delegations of scientists specializing in the field of nuclear power reactors, including breeder reactors, for visits to facilities in the USA and the USSR.

"3. Delegations of scientists in the field of high energy physics, for visits to facilities in the USA and the USSR.

"4. Delegations of scientists working in the field of nuclear physics, neutron physics, and the structure of the nucleus, for visits to facilities in the USA and the USSR.

"The above visits, as well as additional exchanges of visits which may be developed in these and other fields of the peaceful uses of atomic energy, shall be carried out in accordance with the following procedures:

"1. The specific dates and duration of visits, the specific numbers and identification of scientists and facilities involved, and the specific field of activity contemplated by each side for each of the visit exchanges, will be developed between the U.S. Atomic Energy Commission and the USSR Main Administration for Utilization of

V. S. Emelyanov, head of the U.S.S.R. Main Administration for Utilization of Atomic Energy, and John A. McCone, chairman of the U.S. Atomic Energy Commission, signing a memorandum providing for a program of reciprocal exchange in the peaceful uses of atomic energy between their respective countries.

Atomic Energy and confirmed through diplomatic channels. At the same time, the respective governments will specify the permissive travel to be afforded beyond the location of the facility involved.

"2. In all cases the sending country will pay the salary, subsistence, travel costs and other expenses of their own scientists and personnel both to and from their main destination and within the host country. The host country will be responsible for making suitable arrangements such as hotel accommodations and travel and to provide necessary interpreters.

Exchange of Information

"The Parties agree to exchange information on a reciprocal basis through the exchange of documents, reports and abstracts. Conferences may be held as agreed.

"The Parties agree to:

"1. The exchange of abstracts of unclassified work in peaceful uses of atomic energy being conducted in their countries. This would include abstracts of both formal reports which are published in the technical literature as well as informal and progress reports which are normally only circulated within the atomic energy programs of their respective countries.

"2. In the research reactor and power reactor field, the provision of full-size copies of such unclassified reports as are listed in the abstracts and as are requested by the other party.

"3. The exchange of information on radio-isotope production and processing development, techniques of application and high intensity sources.

"4. Abstracts and reports exchanged by the Parties shall also be made available to the International Atomic Energy Agency.

Joint Enterprises

"The Parties agree initially to examine separately the feasibility of engaging in joint projects in various unclassified areas.

"Included in the initial exploration are joint facilities and undertakings in controlled thermonuclear reactions; the design and construction of an accelerator of large and novel type; approaches to waste disposal problems; nuclear data evaluation and compilation; and the development of nuclear standards.

"Representatives of the U.S. Atomic Energy Commission and the USSR Main Administration for the Utilization of Atomic Energy will meet in the first half of 1960 to consider what enterprises merit further study and will request the International Atomic Energy Agency to assist in arranging such meetings.

Instruments

"The Parties agree to consider the possibility of making available new scientific instruments under agreed terms and on a reciprocal basis. Such arrangements will proceed only to the extent mutually agreed and permissible under the laws and export policies of the respective countries."

Efforts To Control Locusts in Africa Described

Devastations, famine, and misery caused by locust plagues in Africa and other tropical countries have been recorded since the beginnings of human history. For a long time peoples of those lands have had no means of defense, and it is now natural to ask whether the recent rapid progress of science has insured that crops will provide food for men, not locusts.

Technical methods of locust control are now extremely effective. There are poisons, harmless to man and domestic animals if reasonably used, but so powerful against locusts that a few ounces, diluted in oil and sprayed by aircraft as a fine mist on plants or into the flying swarm, will kill millions of the pests. These methods are used on a large scale in many countries and have been particularly successful in Morocco, Mauritania, Senegal, Chad, Sudan, Ethiopia, Somaliland, Kenya, Tanganyika, the Middle East, Pakistan, and India. Swarms extending over scores of square miles have been exterminated, and impending danger from them has been averted.

Antilocust Organizations

Most of the countries threatened by locusts now have special antilocust organizations, but as recently as 1953 locusts caused losses in the Somaliland Protectorate estimated at £250,000 ($700,000), and in 1954 crops in Somalia suffered to the extent of £600,000 ($1,680,000), while Morocco lost valuable export crops worth £4 million ($11.2 million). In 1958, locusts destroyed crops in Ethiopia which would have been sufficient to feed 1 million people for a year. In 1959 a similar disaster occurred, and food had to be imported to prevent famine.

Such disasters are less frequent now because many countries can put up a defense against invading locust hordes, but this is achieved at great expense by maintaining defensive organizations even during quiet years. Thus, the East African territories (Kenya, Tanganyika, and Uganda) have spent, on the aver-

A locust control officer in Africa views an approaching swarm. A single swarm may number 500 million and destroy 200 square miles of vegetation.

age, nearly £750,000 ($2.1 million) each year on organizations to control the desert locust.

Swarms of the desert locust roam freely over a vast area of Africa, from the Atlantic coast through West African territories (including Gambia, Sierra Leone, Ghana, and Nigeria) to the Chad and Sudan republics, Ethiopia, Somaliland, and Aden Protectorate, as well as to Kenya, Tanganyika, and Uganda and across the Middle East to Pakistan and India.

The main concentrations vary from year to year, and some countries may be free for a period while others are so heavily invaded as to be unable even to defend their crops. The result is that, in spite of every effort on the part of territorial forces, only part of the swarms present in one season over the whole vast invasion area are killed. In the next year, another group of territories is invaded and their antilocust forces may be overwhelmed, while the forces in the temporarily more fortunate countries are standing idle, but still demanding funds in order to be ready for the next onslaught.

The present use of highly efficient antilocust forces for local defense only is the main cause of failure to reduce the current desert locust plague, which has continued, with only brief intervals of respite, for the last 20 years. The locust swarms move over hundreds and even thousands of miles, across frontiers which often present unsurmountable barriers to territorial antilocust forces.

Efficient Information

Major concentrations of locusts are now predictable, because of the efficient International Desert Locust Information Service, operated by the Anti-Locust Research Center in London, with support from the Food and Agriculture Organization of the United Nations. It would be possible, therefore, to move the technical personnel and equipment to any danger points and to attack the locusts in an area where a far-reaching victory, not merely a minor local success, would be scored.

Practical plans for organizing strategically important operations against the desert locust are being considered by FAO. They envisage a free exchange of antilocust forces across frontiers, so that help could be given to a heavily-engaged neighbor. This can be done, provided there is a previous general agreement on mutual help between adjoining territories, and provided a strong and highly mobile antilocust reserve unit, which would give powerful support to local forces when necessary, is created.

Control of Two Kinds of Locusts

Such cooperation has already proved to be practicable and effective in the control of two other kinds of locusts which devastated Africa until recently. They are the migratory locust and the red locust, and their main areas of destructive action were to the south of the desert-locust region, in many of the most fertile countries in Africa. Scientific investigations showed that each of these species had main areas of outbreak, from which swarms spread over the greater part of the continent. Once these sources of invasion were discovered, agreements were concluded between the countries to establish and to maintain jointly an international control organization for each locust species.

These permanent organizations have now been in existence for some 15 years, maintaining a close watch on the locusts and killing the first small swarms that threaten to develop and to escape from the breeding areas. No such escapes have occurred since these organizations were formed.

The desert locust, unfortunately, presents a much more difficult problem. Since it has no narrowly delimited outbreak areas, its swarms migrate freely over enormous distances and breed wherever rain occurs. It is, therefore, not yet possible to hope to prevent plagues of desert locusts, but effective international and interterritorial cooperation can do much to reduce the danger to the rapidly expanding agriculture of Africa and the Middle East.

B. P. UVAROV

Locust Research Center,
London, England

Foundation Makes Grant for Woods Hole Research Vessel

Oceanographers are to have a new research vessel that is being provided through a $3–million National Science Foundation grant to the Woods Hole Oceanographic Institution. The new vessel will replace the R.V. *Atlantis*, 28-year-old "flagship" of the institution's fleet.

The grant results from a foundation-sponsored series of informal conferences among government and private oceanographers to assess the problem of inadequate vessels for oceanographic investigations. Because of the probability that NSF would be asked to support research-vessel construction, it made a grant to Woods Hole in 1958 to study capabilities and preliminary designs of various sizes and types of craft. This study, in turn, benefited from earlier studies made by the institution with funds provided by the Office of Naval Research.

A new and distinctive type of research vessel has been evolved from these studies, which combines the best features of seaworthiness and performance to be found in the "fat" trawler and the "lean" Coast Guard cutter. The new vessel will be able to operate under weather conditions too severe for all but one of the present Woods Hole vessels and is expected to be one of the most efficient and versatile research ships afloat.

The vessel will have an over-all length of 175 feet, a beam of 36 feet, and a displacement, when loaded, of 1040 tons. She will have an operating range of 7500 miles and a cruising speed of 12 knots. The ship's complement will be 37 people, of whom 19 will be scientists and the rest officers and crew. Preliminary design plans were prepared by the firm of M. Rosenblatt and Son of New York.

Public attention was focused on the needs of U.S. oceanography in February 1959 when the Committee on Oceanography of the National Academy of Sciences published a report, *Oceanography 1960 to 1970*. The report recommended that the United States Government, as well as private sources, should expand support of the marine sciences sufficiently to stimulate a doubling of basic research in the field within the next 10 years, and that several agencies, including the National Science Foundation, should assist in the financing of new research ship construction.

Actually, the National Science Foundation as early as 1956 had considered the advisability of providing financial support for the construction of oceanographic vessels. It was recognized that existing oceanographic vessels would require replacement, and also that the total "United States fleet" of oceanographic vessels would have to be enlarged. Because of the increasing importance of this field of science and the great cost of the vessels, it was early realized that the Federal Government would have to play a significant role.

The United States Navy has been a primary source of support for oceanography, both for basic research and for projects of a specific military nature. It has joined civilian oceanographers in urging increased foundation support. The Navy has also requested funds for constructing its own oceanographic research vessels.

Under the terms of the new NSF grant, the Woods Hole Oceanographic Institution will submit detailed construction plans for foundation approval. The agreement provides for NSF concurrence in plans for solicitation of bids, award of the contract, and inspection of construction. The institution will operate and maintain the vessel.

Houssay Heads Physiology Union

Bernardo Houssay, chairman of the National Research Council of Argentina, has been elected to serve for the next 3 years as president of the International Union of Physiological Sciences. He is shown here presiding over the opening session of the 21st International Congress of Physiological Sciences, of which he was president. It was later in the congress, which was held last August in Buenos Aires, that the International Union's general assembly elected him to the 3-year term. Houssay, who won the 1947 Nobel Prize in Physiology and Medicine, is director of the School of Medical Sciences of the University of Buenos Aires.

Bernardo Houssay (center), new president of the International Union of Physiological Sciences.

Grants, Fellowships, and Awards

Teacher fellowships. In order to encourage highly qualified secondary-school teachers to improve their competence by working at the graduate level in the various fields of science and mathematics, the National Science Foundation is again offering a program of summer fellowships for secondary-school teachers of science and mathematics. Several hundred awards will be made for study beginning in the summer of 1960 and continuing for as many as three successive summers. The program is being administered for the foundation by the American Association for the Advancement of Science.

Fellowships will be awarded to support individually planned programs of study in the mathematical, physical, and biological sciences acceptable by the fellowship institution toward an advanced degree in one of these sciences. Although fellows will not be required to pursue courses of study leading to an advanced degree, they will be required to pursue studies at that level.

This fellowship program is in addition to the foundation's support of institutes for teachers. In the institutes' programs, teachers are afforded opportunities to study in courses of instruction especially designed for groups of teachers. Institute participants are chosen by the staff of the institute according to locally established criteria. In the fellowship program, fellows may pursue individually planned graduate-level study programs at institutions of their choice.

An applicant must (i) be a citizen of the United States, (ii) be a science or mathematics teacher in a secondary school (and have had 3 years' experience in that capacity), and (iii) hold a baccalaureate degree or its equivalent. Applicants will be evaluated by panels of scientists chosen especially for this task by the AAAS.

Stipends will be computed at the rate of $75 for each week of tenure. Travel and dependency allowances will ordinarily be provided, and the foundation will pay for tuition and required fees.

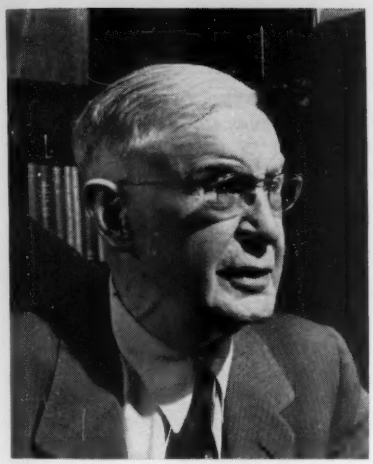
Teachers should *not* submit their applications directly to the National Science Foundation. Rather, information and application materials may be obtained by addressing a request to Secondary School Fellowships, American Association for the Advancement of Science, 1515 Massachusetts Ave., NW, Washington 5, D.C. Completed applications must be received by the association by *15 January 1960*.

Scientists in the News

William A. Hamor, senior director of research at the Mellon Institute, Pittsburgh, Pa., will retire on 31 December after 45 years at the institute. Hamor, who is a specialist in the literature of chemistry, is the author or co-author of nearly 200 articles and publications, including five books. During his years at Mellon he has also edited articles, books, and other publications.

In 1950 Hamor received the Pittsburgh Award of the American Chemical Society for "outstanding service to chemistry." Since 1947 Hamor has been editor of the American Chemical Society's Chemical Monograph series. In addition, he served on the committee that established the Priestley Medal and the committee that formed the petroleum division of the society. At one time he wrote a column on industrial developments for the then *Journal of Industrial and Engineering Chemistry*, which carried the first industrial news to appear in any of the society's journals. Later, for 6 years, he wrote annual reviews of industrial research development for *Chemical and Engineering News*.

Hamor has also been cited as an authority in the field of industrial hygiene. Early in his career he conducted research on the chemistry and toxicology of anesthetics, and later, research



William A. Hamor [Clyde Hare]

on smoke control; the latter study contributed to a better understanding of chemical factors in municipal planning. In 1934 he was influential in the establishment of the Industrial Hygiene Foundation, now composed of 400 member companies and public agencies. In 1945 Hamor served as chairman of the Smoke Abatement Committee of the Allegheny Conference on Community Development. The conference was largely responsible for the adoption of smoke control measures in the Pittsburgh district.

Hamor is a graduate of the University of Pittsburgh, where he served as professor of chemistry from 1913 to 1918. He has received honorary degrees from the University of Pittsburgh, Grove City (Pa.) College, the University of Louisville, and the University of Miami (Fla.).

Bowen C. Dees has been appointed assistant director of the National Science Foundation for scientific personnel and education. Dees has served the foundation since 1951, most recently as deputy assistant director for scientific personnel and education.

Cornelius Lanczos of the Dublin Institute for Advanced Studies, at present visiting professor of mathematics at the University of Wisconsin, has been named winner of the 1960 Chauvenet Prize of the Mathematical Association of America for his paper "Linear Systems in Self-Adjoint Form," which appeared in the *American Mathematical Monthly* [**65**, 665 (1958)]. The award will be presented in Chicago on 29 January 1960 during the Mathematical Association's annual meeting.

The Yale University School of Medicine has reported the following appointments:

William C. Gibson, Kinsmen professor of neurological research at the University of British Columbia, will be visiting professor of the history of medicine during the first 3 months of 1960.

Horst Bickel, assistant professor at the University Children's Hospital, Marburg an der Lahn, Germany, is just completing an assignment as visiting associate professor of pediatrics. He is teaching and continuing his research in the field on inborn errors of metabolism.

Noah Lichtenstein, associate professor of biochemistry at the Hebrew University in Jersualem, is serving this year as visiting associate professor of biochemistry. He is teaching and participating in graduate seminars.

Gertrude M. Cox has resigned as director of the Institute of Statistics of the Consolidated University of North Carolina. She will continue for the present as professor of statistics at North Carolina State College.

Louis Herman, lecturer and consultant for the French Atomic Energy Fusion Group, is on leave and will spend the year at the Geophysical Institute, University of Alaska. His work will be in spectroscopy and will relate to auroral zone phenomena.

M. G. Candau (Brazil), director-general of the World Health Organization, has accepted the 12th World Health Assembly's offer to extend his term of office by 3 years. Candau was first elected WHO director-general in 1953. His present directorship expires 20 July 1960.

Eugene L. Church, a theoretical nuclear physicist for U.S. Army Ordnance, Pitman-Dunn Laboratories Group, Frankford Arsenal, Philadelphia, has received a Secretary of the Army's Research and Study Fellowship to study for a year at the Bohr Institute for Theoretical Physics, in Copenhagen.

R. H. Painter, entomologist at Kansas State University, has received the Gamma Sigma Delta national award for distinguished service to agriculture. Painter was cited as an outstanding teacher and as an authority on insect control through host plant resistance.

Geoffrey M. Jeffery, senior scientist at the laboratory of parasite chemotherapy, National Institute of Allergy and Infectious Diseases, has received the Bailey K. Ashford Medal established by Eli Lilly and Co. **Herbert C. Clark**, retired director of the Gorgas Memorial Institute in Panama, has received the Richard Pearson Strong Medal, given by the American Foundation for Tropical Medicine. The awards, given for contributions to tropical medicine, were made at the annual banquet of the American Society of Tropical Medicine and Hygiene held 30 October in Indianapolis, Ind.

Recent Deaths

Philip F. Bonhag, Berkeley, Calif.; 36; associate professor of entomology, University of California; 1 Nov.

Linn F. Cooper, Sarawak, Borneo; 60; physician who conducted extensive research on time distortion in dreams; 13 Nov.

James T. W. Granady, New York, N.Y.; 70; hematologist and specialist in sickle-cell anemia; 12 Nov.

Otto F. Hunziker, La Grange, Ill.; 85; dairy scientist and retired director of research laboratories for the 23 factories of the Blue Valley Creamery Co., Chicago; former head of the dairy department at Purdue University; 15 Nov.

Charles R. Jacobson, Orange, N.J.; 31; director of chemical research for the Knoll Pharmaceutical Company; 9 Nov.

Edward D. Rudderow, Stamford, Conn.; 87; physician in general practice in New York for 50 years and former professor at New York Medical College; 15 Nov.

Edgar C. Schenck, New York, N.Y.; 49; director of the Brooklyn Museum, archeologist, author; 16 Nov.

William Schoenfeld, Corvallis, Ore.; 71; agricultural economist who retired in 1950 as dean of the School of Agriculture at the University of Oregon; 13 Nov.

Otto H. Swezey, San Jose, Calif.; 90; retired chairman of the department of entomology, Hawaiian Sugar Planters Experiment Station; 3 Nov.

Charles Tilden, New York, N.Y.; 86, professor emeritus of engineering mechanics at Yale University; 15 Nov.

Charles Wilson, Edinburgh, Scotland; 90; 1927 Nobel Prize winner in physics; retired professor of natural philosophy, Cambridge University; 15 Nov.

Book Reviews

Organizing Peace in the Nuclear Age. Commission to Study the Organization of Peace. Arthur N. Holcombe, Chairman. New York University Press, New York, 1959. xvii + 245 pp. $3.75.

This volume is the 11th report of the research affiliate of the American Association for the United Nations and the third volume in a series dealing with the problem of strengthening the United Nations. Its special interest to readers of *Science* lies in one of its three supporting papers—"Atoms for peace; the International Atomic Energy Agency," by John G. Stoessinger.

In addition to Stoessinger's paper, the book also contains a short report by the Commission and two other supporting papers: Quincy Wright's careful study, "The role of law in the organization of peace," and Arthur M. Holcombe's rather original treatment of politics in international organizations—a treatment which follows lines familiar in studies of domestic partisan politics, but seldom applied in studies of foreign affairs.

Let us focus attention on Stoessinger's discussion of the International Atomic Energy Agency and on the recommendations in the Commission's report which deal with atomic energy. Much of Stoessinger's paper is devoted to a detailed and scholarly review of the history of that unhappy agency. The story starts with a dramatic gesture by President Eisenhower, committing us to providing fissionable materials to other countries, through an international agency, to help develop peaceful uses of the atom. It was a gesture which fitted well into the prevailing idealistic and unrealistic expectations about what atomic energy could do to aid in the development of underdeveloped nations.

The generosity and good will indicated by the American stand undoubtedly had some beneficial effects on foreign attitudes, but the problems which the proposal had failed to anticipate made themselves felt from the beginning of the negotiations. The nations involved were split several ways. The United States Government insisted on high standards of inspection and control to ensure that the material sold by the IAEA would not be diverted to military use; such diversion would bring to a head the nightmare of the *n*th country problem. The Soviet Union and the underdeveloped countries (the latter haunted by fears of colonialism) objected to the free movement of inspectors and to other similar safeguards. The safeguards being discussed were to be applied to the recipients of fissionable or source materials. Thus, they provided no protection except against abuses by the less-developed countries, that is, the countries with the least nuclear potential. Such provisions were clearly of limited efficacy and were discriminatory between countries. Other issues found the United States and the Soviet Union, as nuclear powers, aligned together against the nuclear have-nots. Later, when the organization was formed, the Board was subjected to all these political pressures and found itself frequently in conflict with the Secretariat, where the technicians' views tended to dominate.

These problems, as well as poor leadership (which Stoessinger chooses not to stress), have left the International Atomic Energy Agency with a relatively small record of accomplishment. Nations have preferred to buy and sell fissionable and source materials through bilateral and regional agreements. Incidentally, such purchases are cheaper, since the IAEA would normally obtain its materials at market prices and, thus, would need to resell at somewhat higher prices. Sales and purchases through the IAEA entail opening up such operations to international inspection, which could mean inspection by Soviet as well as Western inspectors. Since inspection is applied only to recipient countries, this means inspection by Soviet citizens abroad without a corresponding Soviet concession to other nations.

As a result of all these problems the IAEA, to date, has sold only 3 tons of natural uranium (to Japan) and is currently negotiating a sale of enriched uranium (to Finland). Most of the agency's activities have necessarily been channeled into other fields—for example, a fellowship program for training atomic scientists in underdeveloped countries, and working out proposed standard practices for health and safety. In short, the IAEA, started with much fanfare, now promises to become a useful though relatively minor agency with a strictly technical function for working out cooperation on administrative matters among those nations who see advantages in such cooperation.

Some lessons of this experience are implicit in Stoessinger's story. But Stoessinger does not underline these lessons, and in the Commission's report they are on the contrary substantially denied. The whole experience illustrates once more how little leverage there is in foreign policy proposals based solely on abstract notions of welfare without reference to national interests. It takes genius in statesmanship to mobilize powerful considerations of national interest behind desired goals of peaceful cooperation. Too often, instead, policies are adopted which place national interest on one side and considerations of broad principle on the other. When these desiderata are thus divorced, the gestures made to idealism and principle look very shallow indeed.

It is, as the authors point out, in the interest of both the Soviet Union and the United States to prevent the spread of the nuclear club except, perhaps, to a very small number of the closest allies of both nations. It is not inconceivable that hard bargaining on this point of common interest could lead to an agreement in the interest of both sides, with each making concessions on peripheral points. But it is very hard to see what motivation would lead either the United States or the Soviet Union to channel such support of atomic energy development as each gives to its trusted allies through a control scheme of the IAEA, except in return for a guarantee compelling

the other to do the same in all instances, military as well as civil. In short, by isolating the control of peaceful uses of atomic energy from the control of atomic energy for military purposes, attempts at the former goal have been rendered relatively sterile and futile. The strong motivations which exist for accepting military controls have been rendered irrelevant to the civil situation. This leaves no strong motive of national interest operating in favor of international control of the Atoms-for-Peace program.

Yet the Commission in its report says, "We strongly urge the United States to make the International Atomic Energy Agency the focal point and major instrumentality of its activity in support in the development of the peaceful uses of atomic energy in other countries. In specific terms, the United States should give priority to the Agency rather than to bilateral or regional arrangements." I can see little force in the arguments educed for such a policy; this policy would lead every agreement with our friends into a maelstrom of quibbling in an agency where representatives of the Soviet Union and the neutralist countries also sit. It is hard to see why we should invite all the difficulties entailed in taking action under such unfavorable circumstances when there are opportunities for easy cooperation opened up by the effective unity within the Western alliance and similar groupings. The argument in favor of channeling activities through the IAEA amounts essentially to a demand that we set an example for the Soviet Union because it might then, also voluntarily, use the IAEA for the operation of the Soviet atomic cooperative programs. Example setting is, unfortunately, flimsy strategy in international affairs.

In closing, let me emphasize that the alternatives are not restricted to setting an example by actions that are contrary to national interest on one hand or by engaging in a suicidal, nuclear balance-of-power game on the other. Nuclear energy clearly requires international control. We will have to accept the imposition of such controls upon us as a price for imposing them upon others. The interest that nations have in survival is likely to produce whatever world-wide agreements are, in fact, reached. It is not at all clear that quarantining certain subordinate, though still important, areas of international relations from infection with the great issues of war, peace, and power conflict is possible, or even, if possible, likely to be constructive.

Nor is it clear that piecemeal reductions of tensions improves the chances for peace. It is not clear that piecemeal restrictions on atomic capabilities or even atomic weaponry, for example, reduce the likelihood of atomic catastrophe. It is most probable that such functions are nonlinear, nonmonotonic, and discontinuous, and if that is so, one cannot assume that a small sacrifice designed to promote a little progress toward international control of peaceful atomic energy activities will, at the same time, be a step toward preventing an atomic holocaust. The case must be established, if at all, by close reasoning about the particulars of the international bargaining situation.

While these issues are not faced in the present volume, the historical record is clearly and accurately stated. Scientists concerned with defense and atomic energy matters will find this case study both instructive and informative.

ITHIEL DE SOLA POOL
Center for International Studies, Massachusetts Institute of Technology

Bigger's Handbook of Bacteriology. For students and practitioners of medicine. Seventh edition by F. S. Stewart. Williams and Wilkins, Baltimore, Md., ed. 7, 1959. x + 611 pp. Illus. + plates. $8.

Since the last edition of this excellent *Handbook* (1949), the many advances made in several of the fields of bacteriology have necessitated revision of much of the original text. New sections have been added on virology and chemotherapy, as well as new chapters on disinfection, antigens and antibodies, hypersensitivity, bacterial classification, and streptococci and coliform bacteria.

A great deal of technical material included in the earlier editions, which was of value to the laboratory technician, has been deleted. The chapters on pathogenic fungi and protozoa have been omitted, because it was felt that these specialized subjects required specialized treatment.

While the text has been increased by approximately 100 pages, the *Handbook* was held to Bigger's objective (expressed in the preface to the first edition)—to present "all the more important facts relating to bacteria as far as they affect man" in a small volume.

While this text is primarily intended for students of medicine, it appears to offer a wealth of material for the student nurse.

The illustrations and plates are excellent.

A. EDWARD A. HUDSON
Goldsboro, North Carolina

Immunity and Virus Infection. A symposium. Victor A. Najjar, Ed. Wiley, New York; Chapman and Hall, London, 1959. viii + 262 pp. Illus. $10.50.

This book contains 20 papers presented in May 1958 at Vanderbilt University during a symposium planned by the department of microbiology as a tribute to the interests of a distinguished guest, Sir MacFarlane Burnet. Besides being devoted to the disciplines of immunology and virology, the volume has no formal organization, and it includes a variety of topics. It begins with a brilliant and provocative discussion of the clonal selection theory of antibody production by Burnet. Antibody production and the related problems of immunological tolerance and allergy are discussed by several participants. The other immunological topics included are separation and purification of antibodies, properdin, rheumatoid γ-globulins of high molecular weight, and genesis of fever in infection. The section on virology (also introduced by Burnet) begins with a highly speculative paper on trends in virus research. Luria, in the same vein, attempts a new definition of viruses, based on recent findings in genetics. Three papers deal respectively with the purification of viruses, the role of phage in the toxigenicity of *Corynebacterium diphtheriae*, and virus infection by "naked" ribonucleic acid. The three final papers are devoted to the problems associated with vaccination against poliomyelitis with inactivated or live attenuated virus, and to the effect of vaccination on the epidemiology of the infection.

The method of presentation varies considerably, too. A few authors discuss specific problems, but most summarize and discuss recent developments, while some thoroughly review old as well as new lines of investigation and provide

extensive bibliographies. The book contains an ample number of good illustrations and an adequate index.

In this age when scientific information multiplies so rapidly (a fact fully reflected in this book), one may justifiably ask whether the publication of a symposium of this type serves as a good method for rapid and wide communication to students and scientists. Because of the tenuous organization of the subject matter, the answer is not an unequivocal yes, but the papers are excellent and the book provides invaluable information on a number of current topics.

EMILIO WEISS
Naval Medical Research Institute, National Naval Medical Center, Bethesda, Maryland

Free Radicals. An introduction. A. F. Trotman-Dickenson. Methuen, London; Wiley, New York, 1959. 142 pp. $2.50.

When I reviewed Trotman-Dickenson's book *Gas Kinetics* [*Science*, **123**, 639 (1956)], I praised it because it gave "a useful summary of working equations . . . a critical review and tabular summaries of experimental results . . . a detailed description and evaluation of several recently developed experimental methods." *Gas Kinetics* is a useful monograph on a technical corner of the field of chemical reactions; the present book, *Free Radicals*, is a highly personal exposition in the broad area of physical and organic chemistry where, in either gaseous or liquid systems, one encounters free radicals. The treatment is so personal that I need to heed "*de gustibus non disputandum est*," and any statements I make are necessarily a comparison of my tastes with those of the author.

The book consists of three short introductory chapters (24 pages) on the general aspects, history, production, and properties of free radicals; a long chapter (94 pages) on the reactions of monoradicals; a short chapter (13 pages) on biradicals; a very short list (37 references) of books and review articles; and a short subject index. A bibliography is not given, although a few names and dates and a few references are given at various points in the book.

Because it is a personal account of the broad field, this book has the same purpose and follows the same pattern as Semenov's *Some Problems in Chemical Kinetics* (translated by M. Boudart; Princeton University Press, 1958); yet the treatments differ as much as the personalities of the authors. Of the two books, Semenov's is more original. Surprisingly enough, in the list of references given in Trotman-Dickenson's book, (Chapter 6), no mention is made of Semenov's.

In *Gas Kinetics*, the exposition of theories of reaction rates was very weak. This weakness is carried over into the present book, and many specific examples could be pointed out. One example occurs in the discussion of the rate of radical recombinations (pages 38–39) where we are told ". . . the rate constants . . . approach the collision rate . . . and are two or three orders of magnitude above the value predicted by transition state theory." Using transition state theory, E. Gorin predicted the rate constant for recombination of methyl radicals to be 1.5×10^{13} cm^3/mole-sec [*J. Chem. Phys.* **7**, 643 (1939)]; the observed value is 2.2×10^{13} cm^3/mole-sec [A. Shepp, *J. Chem. Phys.* **24**, 639 (1956)]. For recombination of trifluoromethyl radicals, transition state theory predicts 1.7×10^{12}; the observed rate is 2.3×10^{13} [P. Ayscough, *J. Chem. Phys.* **24**, 944 (1956)]. Obviously Trotman-Dickenson has not taken the pains to follow the literature or to understand the methods of activated complex theory. Of course, he is not the only one who has erred in this respect. The physical chemists' education usually includes too little mathematics and theoretical physics for understanding the main current of theoretical developments. Too often chemists, frustrated because they do not understand a theory, misapply the theory and then proclaim its "failure."

The unique advantage of this book is the author's conscious attempt to unify and cover two or three fields which are usually treated separately. Who might profitably read this book? Certainly not novices in chemical kinetics (one should disregard the subtitle, "an introduction"). However, the portions based on gas phase photochemistry could profitably be read by solution kineticists; and gas phase kineticists could well review the items on the chemistry of reactions in solution. The role of this book, then, is to widen the horizon of narrow specialists in chemical reaction kinetics.

HAROLD S. JOHNSTON
Department of Chemistry, University of California, Berkeley

Fallacies in Mathematics. E. A. Maxwell. Cambridge University Press, New York, 1959. 95 pp. $2.95.

Almost everyone who has studied high-school mathematics has been confronted with proofs that $0 = 1$ and that every triangle is isosceles. This book is concerned with these and many more fallacies, defined by the author as proofs which lead by guile and plausible reasoning to a wrong conclusion. Some of the fallacies are of a trivial nature; others lead to a deeper understanding of the mathematics involved. Examples of both kinds are given, but much more emphasis is placed on the nontrivial fallacies, most of which come from the domain of geometry.

Maxwell first gives a number of fallacious proofs from some discipline of mathematics such as geometry, algebra, differentiation, or integration, and asks the reader to discover the fallacious step in the argument. Then he provides a commentary on each fallacy; this may consist of a few words or a long discussion. Several of the discussions on the geometrical fallacies presuppose a sound knowledge of geometry, which an English college freshman may already have but which an American student acquires only if he takes college geometry.

The book ends with a series of howlers which are almost the opposite of fallacies; here we find solutions of problems by incorrect methods that lead to correct results. These howlers were taken from real life and provide a certain amount of amusement. However, much more enjoyment as well as enlightenment is provided by trying to detect the fallacies, or at least by reading the solutions given by the author of this lovely little work.

PHILIP RABINOWITZ
Weizmann Institute of Science, Rehovoth, Israel, and National Bureau of Standards, Washington, D.C.

The Thirteen Steps to the Atom. Charles-Noël Martin. Franklin Watts, New York 1959 (translation of *Horizons de France*, 1958). 256 pp. Illus. + plates. $4.95.

The thirteen steps of the title are the thirteen successive divisions by ten from 1 centimeter to 1^{-13} centimeter. The best part of the book is a collection of 118 superb photographs of such small objects as snowflakes, through such very

small ones as cells, viruses, and molecules, to the ultrasmall atomic level. An accompanying text explains the size range involved and describes the instruments used to see within this range. The text then builds up, in logical order, the nature of matter from particles to atoms, to molecules and macromolecules, to bacteria and crystals and corpuscles, to diatoms and protozoa, and, finally, to snowflakes. The text is simple and requires no scientific sophistication to be understood.

Scientist or layman, adult or juvenile will enjoy the photographs. The author selected them from many sources, and chose each in terms of three criteria, "intrinsic beauty, technical perfection, and the power to stir the imagination." They cover a wide variety of subjects, including (in approximate order of increasing magnification) snowflakes, sections of a flower, the structure of wood, diatoms, human bone affected by radium, particles of latex, melting iron oxide powder, the lashes of spirochaetae of recurrent fever, new and used engine grease, polypeptide fibers, the skin of a microbe, striated muscle, diffraction fringes in an electron microscope, several examples of molecular structure, and the spiraling track of an electron caught in a magnetic field.

The device of starting with objects of familiar size and proceeding by successive steps to the very much larger or very much smaller has been used before, but never, in my memory, with such a magnificent collection of photographs. One of them is reproduced on the cover of this issue of *Science*.

The book would make a fine present for a youngster beginning to be interested in science, if he can get it away from his elders long enough to see it.

DAEL WOLFLE
American Association for the Advancement of Science

The Science of Mechanics in the Middle Ages. Marshall Clagett. University of Wisconsin Press, Madison; Oxford University Press, London, 1959, xxix + 711 pp. Illus. $8.

In the good old order of the history of science, the physicist teaching the elements of mechanics could point to a laughably incorrect "Aristotelian" view of motion. He could then dismiss the Middle Ages, bring Galileo on the scene with a cry of triumph for the experimental method and offer, as evidence for this triumph, the famous Tower of Pisa experiment. Thanks to the efforts of 20th century historians of science, concerned in a more professional manner with the publication and analysis of the rich medieval sources, vast change has been wrought in this crucial area. This work is second only to that in the neighboring field of mathematical astronomy in shedding light on the true antecedents of the more familiar Renaissance activity and in revealing the Middle Ages as being more than a period of simple transmission and stagnation. It is a period, rather, in which many of the basic issues of later mathematical physics were discussed and brought to fruition and which lead in a reasonably continuous way, to the work of Galileo—work that we now realize could not possibly be truly estimated without this knowledge.

For many years, Marshall Clagett has inspired a whole school of collaborators and students to work on medieval mechanical texts and to bring to fruition the labor started by Pierre Duhem, Annaliese Maier, and Alexandre Koyré. This volume represents a definitive and culminating achievement in that study. It collects all the chief medieval texts on statics and dynamics, supplies English translations, and extends, for completeness, from the Hellenistic sources at one end of the time scale to Galileo and Copernicus at the other. Needless to say (for those who know the author) the job is carried out with exemplary and meticulous scholarship, and this volume will clearly stand as the definitive achievement in this field for many years. Now that students have so readily available the texts and good critical commentaries on each, we are happily out of that stage in the historiography of medieval science when it sufficed to know only the names of the authors and the titles of their works.

It is particularly important that we now have an established rationale of the content of medieval mechanical texts, for this volume includes the work of the peculiarly active and unexpectedly original school of theoreticians who worked at Merton College in Oxford during the 14th century. In mechanics, they developed the rich concept of instantaneous velocity and used it in discussions of motion under uniform acceleration. Later, when this grew (probably due to Nicole Oresme in Paris) to include the use of a two-dimensional graphing method as a model for the variation of instantaneous velocity, an important and new part of the mathematical analysis of nature had been achieved. Thus, one must not look upon this book as merely an antiquarian treatment of the medieval origin of one small piece of modern, elementary mechanics. Rather, it is one of the first (and most exemplary) treatments to discuss a vital process in the hard fight that men had to make during the Middle Ages to extend the realm of validity of mathematical treatment from celestial to terrestrial phenomena.

DEREK J. DE SOLLA PRICE
Department of History,
Yale University

New Books

The Performance of Lubricating Oils. H. H. Zuidema. Reinhold, New York; Chapman and Hall, London, ed. 2, 1959. 216 pp. $7.

The Politics of Mass Society. William Kornhauser. Free Press, Glencoe, Ill., 1959. 256 pp. $5.

Reading German for Scientists. Hans Eichner and Hans Hein. Wiley, New York, 1959. 218 pp. $5.25.

Sechzig Jahre Medizinische Radiologie. Probleme und empirie. Hans R. Schinz. Thieme, Stuttgart, Germany, 1959 (order from Intercontinental Medical Book Corp., New York 16). 275 pp. $4.65.

Science and Technology in Contemporary War. G. I. Pokrovsky. Translated by Raymond L. Garthoff. Praeger, New York, 1959. 191 pp. $4.

Sociology. The study of social systems. G. Duncan Mitchell. University Tutorial Press, London, 1959. 183 pp. 11s. 6d.

Spectrum. The world of science. Ray Ginger, Ed. Holt, New York, 1959. 115 pp. $3.95. This volume is intended to present many of the basic ideas of modern science to nonscientific readers—readers who have little knowledge of science and who are aware only of its complexities. Contributors include Glenn T. Seaborg, Herbert Robbins, Melvin Calvin, Bobb Schaeffer, Philip Siekevitz, and D. B. Steinman. Consulting editors are Harold C. Urey, Chauncey D. Leake, Otto Struve, George G. Simpson, William Feller, David Krech, Carl D. Anderson, and Richard S. Crutchfield. Among the more than 100 photographs and drawings are illustrations of the Gulf of California from 140 miles above the earth, the appearance and evaporation of atoms in a piece of platinum, and a crystal of pyrite magnified 2.2 million times.

Systems of Units. National and international aspects. A symposium. Publ. No. 57. Carl F. Kayan, Ed. American Assoc. for the Advancement of Science, Washington 5, 1959. 303 pp. Prepaid to members, $5.75; others, $6.75.

Too Many Asians. John Robbins. Doubleday, New York, 1959. 215 pp. $3.95.

Reports

Natural Selection and the Origin and Evolution of Weeping in Man

Abstract. Tearless crying in the young of early man, with an increased dependency period, would repeatedly have caused dehydration of the mucous membranes, and thus have rendered them vulnerable to the insults of the environment. Tears are bacteriostatic as well as moistening. The hypothesis is advanced that natural selection favored those infants who could produce tears, and that in this way the function became established in man.

It is a curious thing that man is the only creature who weeps—the only creature who sheds tears when he is emotionally distressed. The shedding of tears as an accompaniment of emotional distress has been attributed to other animals, but the fact is that psychic weeping is not known to occur in any animal other than man.

Darwin gave the subject of weeping much thought in his *Expression of the Emotions* (*1*). He suggested that crying in the infant inevitably leads to engorgement of the blood vessels of the eye, and to a concomitant contraction of the muscles around the eyes in order to protect them. "At the same time the spasmodic pressure on the surface of the eye, and the distension of the vessels within the eye, without necessarily entailing any conscious sensation, will have affected, through reflex action, the lacrymal glands. Finally . . . it has come to pass that suffering readily causes the secretion of tears, without being necessarily accompanied by any other action."

As far as it goes this is sound enough, but it does not go far enough. Darwin nowhere ventures a suggestion as to how it has come about that man is the only animal that weeps. The conditions to which Darwin attributes the cause of weeping might have occurred in any number of other species possessing the necessary lacrimal and orbicular muscles. How, then, has it come about that weeping occurs in man alone? Does weeping have any adaptively valuable function in addition to protecting the engorged eye?

As is well known, human infants do not usually cry with tears until they are about 6 weeks of age. Weeping, then, would appear to be both phylogenetically and ontogenetically a late development in the human species. If, as seems probable, weeping was a trait acquired not *with*, but some time *after*, the assumption of hominid status, we have to ask ourselves what factor or combination of factors it was in the development of early man that may have been responsible for the appearance of weeping?

The length of the dependency period of the human child immediately suggests itself. During the earlier part of his dependency period the human infant is without speech or the ability to help himself. His principal means of attracting the attention of others when he is in distress is by crying. Even a fairly short session of tearless crying in a young infant has a drying effect upon the mucous membranes of its nasopharynx. Excessive intake and expulsion of air even in adults will quickly dry mucous membranes, and it is this intake and expulsion of air in the tearless crying infant that may be envisaged as closely associated with the origin and development of weeping. At this point we must briefly discuss the character of the nasal mucosa.

The mucous membrane of the nose lines the nasal passages and covers the scroll-like turbinates. At the entrance to the nasal passages the mucous membrane consists of thick stratified squamous epithelium; except for this small area the whole of the nasal passages is lined with pseudostratified columnar epithelium with many ciliated and goblet cells, except in the olfactory area. There are no ciliated cells in the lower part of the pharynx. The trachea, bronchi, larger bronchioles, and in part the smaller bronchioles, but not the pulmonary alveoli, are lined with ciliated cells.

The tunica propria binds the epithelium to the bony walls and affords space for blood and nerve supply, and for lymphatic drainage. In the tunica propria lie the small tubuloalveolar glands which produce a watery fluid and mucus, the latter containing the important bacteriolytic enzyme lysozyme. These glands are usually classified as serous, mucous, or mixed. The secretions of these glands and of the goblet cells of the tunica mucosa together form a protective investment of the air passages down to the ends of the bronchi. By virtue of the underlying ciliary action the secretions of these glands move in the mucous matrix as a continuous blanket toward the nasopharynx, pharynx, and hypopharynx, where they are swallowed.

It is the mucous membrane of the nose that constitutes the most immediate contact of the respiratory system with the external world. No living cells are so directly exposed to the insults and assaults of the environment. The nasal mucous membrane must withstand the impact of respired air laden with bacteria, dust, particles, and gases. Discharges from the eye entering by the nasolacrimal ducts trickle down over it. The air may be dry or moist, at subzero temperature or very hot, and changes in the temperature of the respired air may vary rapidly from hot to cold. The mucous membrane is adapted to meet all these contingencies.

As for the bactericidal and bacteriostatic efficiency of the mucous membrane, this is well exhibited by the observation of Arnold *et al.*, quoted by Schlaegel and Hoyt (*2*), that 90 to 95 percent of viable bacteria placed on the nasal mucous membrane are inactivated in from 5 to 10 minutes. Bacteria placed in contact with nasal secretions outside the body were much less effectively dealt with. More than 20 years ago Burnet *et al.* (*3*) observed that nasal mucus inactivates poliomyelitis virus of every type in vitro. The bacteriolytic action of the nasal secretions is principally due to the enzyme lysozyme, discovered by Alexander Fleming in 1922.

By drying with a jet of air, the mucous membrane can be inactivated within a few minutes, and death of the ciliated cells can thus be produced. When, for any reason, drying is produced in the mucous membrane, the cilia tend to lose their function and

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Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

soon die. This is followed by a piling up and drying of mucus, and permeability of the mucous membrane. In this state the gelatinous mass of mucus constitutes a most hospitable culture medium for bacteria, which may then in large numbers easily pass through the permeable nasal mucosa. The consequences of this are not infrequently lethal.

The hypothesis proposed here is that, in man, weeping established itself as an adaptive trait of considerable value in that it served to counteract the effects of more or less prolonged tearless crying upon the nasal mucosa of the infant. Infants who cried for prolonged periods of time during the early years of their lives without benefit of tears would stand less chance of surviving than those who cried with tears. Dry crying is dangerous because it renders the organism vulnerable to the invasions of harmful bacteria, and probably viruses, through a dried-out mucous membrane the autosterilizing functions of which have been reduced. Crying with tears, on the other hand, serves to keep the mucous membrane wet and to assist in maintaining as well as reinforcing its functions. Alexander Fleming showed (*4*) that tears contain, among other things, an enzyme elaborated by the lacrimal glands in high concentration—namely, lysozyme, which we have already seen is also secreted by the mucous glands of the nasal mucosa. Lysozyme is highly bactericidal. Caselli and Schumacher (*5*) demonstrated antagonism between lysozyme and electronegative viruses, and Orzalesi and Ciuffo (*6*) obtained very satisfactory results in the treatment of herpetic keratitis and inactivation of the virus with lysozyme. More recently, Ferrari *et al.* (*7*) found that lysozyme inactivates the viruses of many infections such as herpes simplex and herpes zoster, warts, vaccinia, and the like, and reported success in the treatment of diseases produced by these infections with lysozyme. Lysozyme, then, seems to hold some promise, as Fleming had originally expected, in the treatment of virus diseases, and the function of lysozyme in the human organism strongly indicates one of the functions of weeping, especially in the infant and child—namely, as a physiologically protective device against the depredations of potentially noxious organisms. In addition, it should be mentioned that tears contain sugar and protein which are nutritious both to the eye and to the paranasal and nasal mucous membranes. Weeping, furthermore, activates the mucosa, increasing the blood supply and causing the mucosal glands to secrete additional lysozyme.

It is suggested, then, that weeping originated as an adaptively valuable trait in a species in which the crying of the young is extended over a much longer period of time than in any other species, as a protective adjustment against damage to the nasal mucous membrane of the young, and the consequent reduction in fitness; that early in the development of man those individuals were naturally selected in the struggle for existence who were able to produce an abundant flow of tears as they cried, as a preventative of mucosal dehydration, while those who were not able to do so would be likely to succumb more frequently at all ages, and leave the perpetuation of the species increasingly to those who could weep.

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Parietal Eye Nerve in the Fence Lizard

Abstract. A nerve from the parietal eye of the western fence lizard, *Sceloporus occidentalis*, is described as leaving inconspicuously from the third-eye and extending caudally under the dura mater and then ventrally along the left anterolateral surface of the epiphysis to the habenular commissure of the brain. The existence of a parietal nerve must be considered in interpreting the effects of parietalectomy.

A parietal or parapineal nerve from the third-eye of the western fence lizard, *Sceloporus occidentalis*, was not noted in a brief anatomical study preliminary to our investigation of the effects of its removal (parietalectomy) upon behavior (*1*). Unlike the parietal nerve of *Sphenodon* (*2*), *Lacerta* (*3*), and *Chalcides* (*4*), that of *Sceloporus* has an inconspicuous route. In a recent and more thorough study of the "eye" of this form, by means that included electron microscopy (*5*), a parietal nerve was traced in serial sections stained either with hematoxylin and eosin or by Pearse's trichrome-PAS technique. The fine nonmedullated fibers which compose the nerve appear to assemble behind the retina, in a manner not yet determined, course medially and posterodorsally *within* the connective tissue capsule of the "eye," and emerge from its margin where it is attached to the dura mater and integument. Thus, the ventral aspect of the "eye" presents no evidence of the nerve, grossly or microscopically. The parietal nerve extends caudally in intimate association with the anterior pineal artery (*2*, *6*) on the under surface of the dura mater, which is closely applied to the skin in the region of the "eye." Observed in cross section, the diameter of the nerve is seen to be about one-half that of the arterial lumen. At the tip of the epiphysis, or pineal sac, the two structures part company, the artery to the right, the nerve to the left. Both may be traced ventrally between the anterior face of the epiphysis and the posterior wall of the dorsal sac. In sagittal-parasagittal series the nerve is easily followed for a short distance below the tip of the dorsal sac. Ventral to this level the fibers of the nerve seem to spread out, and they are traced farther with difficulty. A few transverse and frontal series provide evidence, however, that the fibers proceed to the base of the epiphysis and enter the habenular commissure.

This description agrees with that of Dendy (*2*) for *Sphenodon*, but not with that of Nowikoff (*3*) for *Lacerta* and *Anguis*, in which the parietal nerve is stated to course to the right of the mid-line. On the other hand, we trace the unpaired anterior pineal artery to the right side of the epiphysis, whereas Dendy (*2*) finds it on the left side of *Sphenodon*, as does Steyn (*6*) in *Cordylus* and *Mabuya*. Finally it should be noted that several workers, including most recently Steyn (*7*), have concluded that a parietal nerve is absent in adult lizards.

In connection with a comparative study of the pineal complex in various reptiles, we have identified the parietal nerve in the following: *Callisaurus draconoides*, *Crotaphytus collaris*, *Draco volans*, *Phrynosoma coronatum*, *P. douglassi*, *Sauromalus obesus*, *Uma inornata*, and *Xantusia vigilis*. The nerve in these forms varies somewhat in size, point of departure from the third-eye, and path to the habenular region of the diencephalon. We have not examined an adequate number of specimens to determine right-left relationships. In the zebra-tailed lizard (*Callisaurus draconoides*) and in the chuckwalla (*Sauromalus obesus*) (two specimens and one, respectively), a small

body containing large nuclei is situated on the parietal nerve near the "eye." Could this be a ganglion? Nowikoff (*3*) noted a similar structure in *Anguis*, which he interpreted as an ectopic piece of retina.

We have studied serially sectioned heads of 16 parietalectomized *Sceloporus occidentalis*, a sample from our field study (*1*). The parietal nerve can be identified in specimens sacrificed 7 to 15 months after parietalectomy. Presumably we are observing only sheath cells and perineurium. Nerve stains have not been used. The strand can be traced in association with the anterior pineal artery from the epiphysis to the former site of the parietal eye where the "nerve" frays out on the surface of the artery or in the remnant of the capsule. Parietalectomy involved the destruction of only the retina and lens (*1*). Older specimens, 18 to 21 months after surgery, show progressive degeneration of the "nerve." In some instances remnants can be found in the vicinity of the epiphysis only. In many the strand is intensely pigmented with black granules of various sizes and shapes. Much of the pigment is within large irregular cells which may be macrophages, or melanophores which have migrated from the meninges, or possibly modified sheath cells.

The finding of a parietal nerve from the third-eye of *S. occidentalis* alters the interpretation of the effects of parietalectomy upon the behavior of the lizard. We had postulated (*1*) that these effects might be attributed to the loss of a hormone produced by the "eye." Injury to and degeneration of the neural connection of the parietal eye to the habenular region of the brain must now be considered. The possibility that the eye has an endocrine function, however, is not negated. Further studies are being conducted to elucidate this point (*8*).

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3 August 1959

Structural Similarities between Hemoglobins A and F

Abstract. A striking similarity has been found between the composition of peptides obtained from tryptic digestion of normal adult hemoglobin (hemoglobin A) and fetal hemoglobin (hemoglobin F).

Normal adult and fetal hemoglobins have been considered to have entirely different structures because of different physical properties (*1*), different immunological characteristics (*2*, *3*), and significant dissimilarities in amino acid composition (*4*). The synthesis of these two hemoglobins has been considered to be under the control of two separate genes (*5*). It was, therefore, surprising to discover a large degree of similarity between fingerprints of tryptic digestion mixtures of these two hemoglobins, a finding which has been confirmed by qualitative analyses of peptides eluted from the fingerprints.

Samples of hemoglobins A and F were prepared by techniques previously described (*3*). Briefly, purified hemoglobin A was isolated by a modification of Drabkin's technique of fractionation against $(NH_4)_2SO_4$ (*6*). Hemoglobin F was prepared from a specimen of cord blood after preliminary treatment with 0.0833N KOH (*3*). The purified hemoglobins were converted to the CO form and kept as the freeze-dried powder at 20°C until used. Hemoglobin A was

Table 1. Qualitative amino acid analyses of the tryptic peptides from hemoglobins A and F illustrated in Fig. 1. The plus symbol indicates a strongly positive amino acid; *tr* indicates a weakly positive analysis. The results which are marked with an asterisk are those wherein a difference between hemoglobins A and F was detected; no spots corresponding in position to 10A and 19A have been found in hemoglobin F. Abbreviations: *ala*, alanine; *arg*, arginine; *asp*, aspartic or asparagine; *glu*, glutamic or glutamine; *gly*, glycine; *his*, histidine; *ileu*, isoleucine; *leu*, leucine; *lys*, lysine; *met*, methionine; *phe*, phenylalanine; *pro*, proline; *ser*, serine; *thr*, threonine; *tyr*, tyrosine; and *val*, valine.

Peptide	Lys	Arg	His	Asp	Glu	Gly	Ala	Val and Met	Ileu and Leu	Ser	Thr	Tyr	Phe	Pro
1A	+		+			+	tr							
1F	+		+			+	tr							
2A	+		+			+	+							
2F	+		+			+	+							
3A	+													
3F	+													
4A	+							+						
4F	+							+						
5A		+							+					
5F		+							+					
6A	+				+									
6F	+				+									
7A		+			+						+			
7F		+			+						+			
8A	+			+				+			+			
8F	+			+				+			+			
9A	+			+	tr*		+*	+	+	+	+			+
9F	+		+*	+	+*	tr*		+	+	+	+		tr*	+
10A	+*		+*		+*			+*	+*		+*			+*
10F														
11A†		+	+									+		
11F†		+	+									+		
12A	+		+	+		+	+	+*	+					
12F	+		+	+		+	+		+					
13A	tr	+	+	+	+	+	+	+	+			+		
13F	tr	+	+	+	+	+	+	+	+			+		
14A	+		+	+	+	+	+	+	+	+	+*		+	+
14F	+		+	+	+	+	+	+	+	+			+	+
15A	+			+			+	+	+	+				+
15F	+			+			+	+	+	+				+
16A	+					+	+	+*	+	+	+			
16F	+					+	+		+	+	+			
17A		+		+	+	+	+	+	+					
17F		+		+	+	+	+	+	+		+*			
18A	+								+	+	+		+	+
18F	+			+*		+*	+*	+*	+	+	+		+	+
19A	+*			+*	+*	+*	+*	+*	+*	+*	+*		+*	+*
19F														

†These peptides are probably composed of two separate peptides, histidine and arginine-tyrosine.

denatured by heating for 2 minutes in distilled water at 95°C, while hemoglobin F was denatured for 10 minutes at 100°C. Ammonium carbonate was then added to each sample to give a final concentration of 0.2M and a *p*H of 8.4. Crystalline trypsin (Worthington 2x, salt free, No. SF685), 2 percent by weight, was added, and digestion was carried out for 5 hours at 37°C. The insoluble "core" remaining at the end of digestion was removed by centrifugation; this constituted from 10 to 25 percent of the starting material and was not examined further in this study. The soluble peptides were lyophilized to remove the buffer salt and resuspended in distilled water, and 2 to 3 mg of the digest was applied to the fingerprints. Two-dimensional chromatography and electrophoresis was carried out on full 18¼- by 22½-in. sheets of Whatman No. 3 filter paper (*7*). The first dimension, descending chromatography in *n*-butanol-acetic acid-water (4:1:5), was followed by electrophoresis for 1 hour at 2000 v in a buffer of *p*H 3.7 composed of pyridine-acetic acid-water (1:10:289). The resulting chromatograms were stained with 0.5-percent Ninhydrin in absolute ethanol or with a starch iodine stain (*8*) to locate the peptides.

Qualitative analyses were carried out on the stronger of the peptides, which could be located on fingerprints stained lightly with 0.025-percent Ninhydrin. The peptide spots so located were washed with acetone and eluted with constantly boiling HCl, in which they were hydrolyzed at 108°C for 18 hours in sealed tubes. After the tubes had been opened and dried over NaOH, the amino acids were resuspended in water and applied to Whatman No. 1 filter paper and run in *n*-butanol-acetic acid-water (4:1:5) followed by pyridine-water (4:1). The amino acids were identified after staining with a 0.1-percent Ninhydrin-acetic acid-collidine system (15:5:2) (*9*). This system separated all the amino acids with the exception of two pairs which cannot be differentiated: caline and methionine, and leucine and isoleucine. Tryptophan was destroyed by acid hydrolysis, while glutamine and asparagine were deaminated to yield the corresponding dicarboxylic amino acids.

Nineteen peptides from the fingerprints of hemoglobins A and F have been subjected to analysis (Fig. 1). These peptides, when eluted, gave consistently high yields of amino acids after hydrolysis. Other peptides are being examined further. Of the 19 peptides analyzed here, 11 were qualitatively the same, five showed minor differences, and only three (Nos. 10, 18, and 19) appeared grossly different (Table 1). The number of peptides expected from complete tryptic digestion of all the lysyl and arginyl bonds in hemoglobins A and F is 29 and 30, respectively (*4*). Since no cystine-containing peptides have been found in this study, it seems likely that the cysteine-residues of the hemoglobins were present, bound together by disulfide bridges, in the "core." Only 65 percent of the expected number of peptides has been found, and it is possible that some of the different peptides described here were from the same part of the peptide chain, a secondary split accounting for the difference (peptides Nos. 1 and 2, for example).

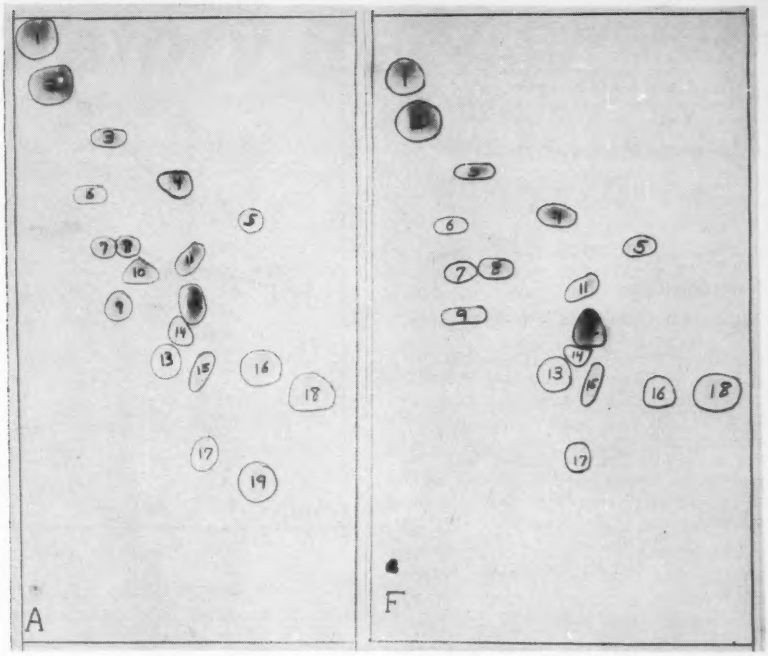

Fig. 1. Fingerprints of hemoglobins A (left) and F (right) stained with 0.5-percent Ninhydrin. The peptide mixture was applied to a spot in the lower left-hand corner of each fingerprint. Chromatography (horizontal) was followed by electrophoresis (vertical), the cathode being at the top of the paper.

The results reported here are consistent with the recent finding that the α-chains of hemoglobins A and F have similar fingerprints and N-terminal amino acids (*10*). While the two chains of hemoglobin have not been separated prior to analysis in the present study, the results show that the qualitative amino acid analyses of most of the tryptic peptides from hemoglobins A and F are identical. In view of the paucity of major differences, it seems likely that the β-chain of these two hemoglobins may be similar, although at least one clear-cut alteration, peptide No. 10, is from the β-chain, since it is the peptide altered in hemoglobin S (*10, 11*). It should also be pointed out that some of the differences noted need not be due to generic differences between hemoglobins A and F but may be due to individual differences between the patients from whom the hemoglobins were obtained (*12*).

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Oxygen Isotope Paleotemperature Determinations of Australian Cainozoic Fossils

Abstract. Fossil marine shells collected in southern Victoria within half a degree of latitude of 38½ °S have been analyzed for O^{18}/O^{16} by mass spectroscopy, and their paleotemperatures have been determined. For the genera *Chlamys, Ostrea,* and *Glycymeris* the temperature rises from early to mid-Tertiary, then falls again to the present.

The method of Urey and his co-workers (*1*) was used to determine paleotemperatures, the experimental accuracy being estimated as about 1°C, made up of instrumental errors and variation in the CO_2 preparations using phosphoric acid. Errors due to alteration of the fossil carbonate cannot be estimated, but a careful selection of shells together with a thorough mechanical cleaning of their surfaces was made to minimize variations. The absolute value of the temperature scale was determined to be within 1°C of the Chicago standard PDB II, but living shells gave values about 2°C lower than averaged sea-water temperatures. Epstein and Lowenstam (*2*) also found a variation between sea-water and shell O^{18}/O^{16} temperatures in Bermuda shoal waters, where pelecypods and gastropods had different growth habits, resulting in different isotope temperatures in the same waters. An *Anadara* shell from Moreton Bay, Queensland, was found by us to have a value 5°C below the sea-water temperature, but this was probably due to its living between tide marks. This mollusk thus lived part of the time at a mud-water interface and part of the time at a mud-air interface.

Mollusks from Melbourne and a limpet from Macquarie Island yielded isotope temperatures about 2°C lower than measured sea-water temperatures. This difference is interpreted as being due to the growth habits of the organisms, to the difference between the mean temperature of the sites where they lived and the sites where the temperatures were measured, or to both. Despite these drawbacks inherent in using specimens from shelf faunas [see also Epstein *et al.* (*1*) and Lowenstam and Epstein (*3*)], a definite picture of the paleotemperature changes can be seen.

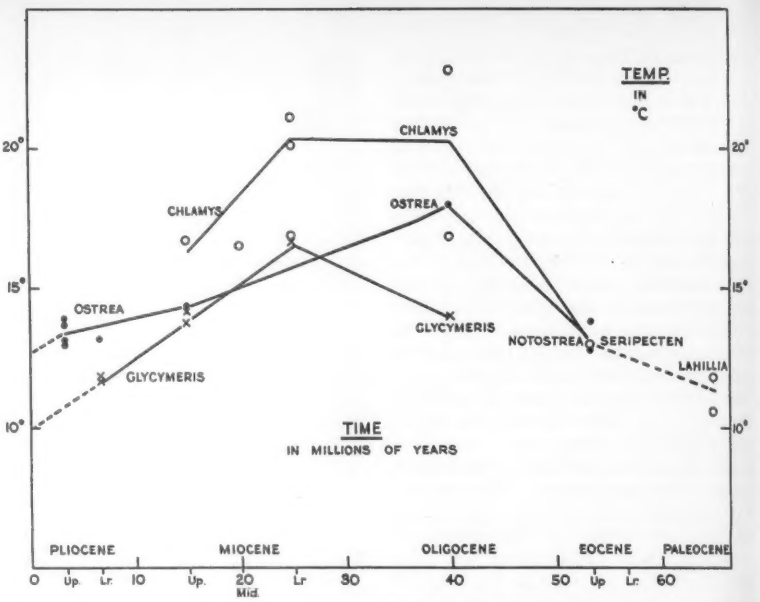

Fig. 1. Results obtained for the Tertiary fossils. The sites which yielded the fossils whose paleotemperatures are given are as follows:

Age	Species	Site
Pliocene		
Lower	*Ostrea*	Grange Burn, near Hamilton
Upper	*Ostrea*	Maretimo member, Whaler's Bluff formation, Portland
Lower	*Glycymeris*	Muddy Creek, near Hamilton
Miocene		
Upper	*Ostrea*	Beaumaris
Middle	*Ostrea*	Bairnsdale
Upper	*Glycymeris*	Beaumaris
Lower	*Glycymeris*	Balcombe Bay
Upper	*Chlamys*	Beaumaris
Middle	*Chlamys*	Bairnsdale
Lower	*Chlamys*	Balcombe Bay
Oligocene	*Ostrea*	Waurn Ponds, near Geelong
Oligocene	*Glycymeris*	Jan Juc formation, Torquay
Oligocene	*Chlamys*	Jan Juc formation, Torquay
Oligocene	*Chlamys*	Waurn Ponds, near Geelong
Eocene		
Upper	*Notostrea*	Brown's Creek, Cape Otway district
Upper	*Notostrea*	Hamilton Creek, Cape Otway district
Upper	*Seripecten*	Hamilton Creek, Cape Otway district
Paleocene	*Lahillia*	Pebble Point, Otway Coast

Figure 1 summarizes the results obtained for the Tertiary fossils. It shows a rise in temperature in the first half of the Tertiary and a fall in the second half. This is in keeping with the biological evidence obtained from the fossils themselves. The Middle Tertiary is characterized by masses of tropical foraminifera such as *Lepidocyclina, Cycloclypeus* and *Carpentaria,* echinoderms such as *Phyllacanthus, Eucidaris* and *Lovenia* and mollusks such as giant cowries and volutes, *Cucullaea* and *Hinnites* (the last two in great numbers). It is not until the Pliocene that the marine fauna is comparable with that living in the same area now. Emiliani (*4*) has also traced this Upper Tertiary fall in temperature for Pacific abyssal waters.

The localities for Pleistocene fossils are the Yarra delta formations (dated in part by radiocarbon), emerged shell beds of the 25-ft eustatic level, and Lower Pleistocene beds (Werrikooian stage) in far western Victoria. The sites which yielded the Tertiary fossils whose paleotemperatures are given in Fig. 1 are tabulated in the legend. Further details are given elsewhere (*5*).

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The General Program of the 126th Meeting of the AAAS in Chicago, 26-31 Dec., 1959, will be available to you within the first week in December—whether you can attend the Meeting or not.

Effective this year, the former General Program-Directory, which had become an unwieldy book of more than 400 pages, has been separated into *two* publications, namely:

a) The Directory of AAAS Officers and Activities, 96 pp., already published; and

b) The General Program of the Annual Meeting, c. 200 pp., which will appear early in December

Both of these, sold at cost, may be purchased separately—in advance (see coupon below), or at the meeting. Some of their *respective* contents are:

The General Program

1. The two-session general symposium "Moving Frontiers of Science IV," arranged by the Committee on AAAS Meetings.
2. Programs of the 18 AAAS sections (symposia and contributed papers).
3. Programs of the more than 80 participating societies.
4. Sessions of the Conference on Scientific Communication, Conference on Scientific Manpower, and the Academy Conference.
5. The Special Sessions: AAAS Address and Reception, National Geographic Society, Phi Beta Kappa, Sigma Xi, RESA, Tau Beta Pi Association.
6. Details of the Morrison Hotel—center of the Meeting—and of the other session sites.
7. Titles of the latest foreign and domestic scientific films to be shown in the AAAS Science Theatre.
8. Exhibitors in the 1959 Annual Exposition of Science and Industry and descriptions of their exhibits.

The Directory

1. AAAS officers, staff, committees, for 1959.
2. Section committees and other AAAS Council members.
3. The 285 affiliated organizations.
4. Historical sketch and organization of the Association.
5. Complete roll of AAAS presidents and their fields.
6. Publications of the Association, including all symposium volumes.
7. AAAS Awards—including all past winners.
8. Future Meetings of the AAAS through 1963.
9. New and current activities of the AAAS.
10. Constitution and Bylaws.

Advance Registration

Advance registration has these decided advantages: 1) You avoid delay at the Registration Center upon arrival; 2) You receive the General Program in ample time to decide, unhurriedly, which events and sessions you particularly wish to attend; 3) Your name is posted in the Visible Directory as the Meeting opens.

The following coupon may be used both by advance registrants and by those who wish only the advance copy of the General Program; the Directory may also be ordered.

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Chicago, 26-31 December 1959

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Meetings

Speleology

The 16th annual convention of the National Speleological Society was held in Springfield, Mo., 1–4 April 1959. The convention brought together specialists in several fields, all of them having a common interest in caves. Speleological investigations include inquiry into the origin and development of limestone caves, examination of fossils and evidences of human activity preserved in them, and study of the specialized biota characterizing caves today. The constant temperature and the uniformity with respect to other physical variables has also made caves a natural laboratory for investigation of mineral formation under conditions known to have been stable for long periods of time. These same uniform conditions have been employed in studies of the physics of cave temperature distribution and air movement. As a common meeting ground, speleology might best be compared to oceanography, which also brings together biologists, geologists, physicists, and workers in related fields.

Several papers were given in Springfield on the geomorphology of limestone terrain. Kennedy Nicholson and W. B. White of Pennsylvania State University described investigations of 8 miles of underground drainage in a karst region in Virginia, and R. G. Deike of Columbia, Mo., presented data suggesting that strike joints are predominant in controlling cave and karst development. An investigation of an area of glaciated karst in northern New York state, by R. R. Anderson of Berkeley Heights, N.J., was contrasted with a reconnaissance of tropical karst in Puerto Rico, by Jeanne Gurnee of Closter, N.J. The geomorphic relations of large single-passage caves in central Missouri were discussed by G. H. Deike, III, of the University of Missouri, and W. B. White and his collaborators noted the effect of geologic structure on cave-passage cross section in Cueva del Guacharo, Venezuela. R. L. Curl of Berkeley, Calif., presented a detailed analysis of the application of solutional markings on limestone as quantitative indicators of water flow in the past.

In an important paper, W. S. Broecker of Lamont Geological Observatory described the first successful attempt at dating the calcium carbonate of cave travertine by the radiocarbon method. Using stalactites of known ages as standards, he found the C^{14} content of speleothems to be approximately 80 percent that of wood of comparable age. The method will find wide application in speleological research. M. G. Mehl of the University of Missouri discussed Pleistocene vertebrate remains in Missouri caves, and H. D. Weaver of Jefferson City, Mo., reported on the abandoned onyx mining industry of Missouri.

The field of cave meteorology was reviewed by R. F. Brown of Davenport, Iowa, who discussed results obtained from instruments stationed in caves in national parks during the International Geophysical Year.

The biologic papers began with a report on the movements and numbers of cave bats in Missouri, by R. F. Myers of the Missouri Cooperative Wildlife Research Unit. Cave salamanders were discussed in three papers: C. E. Mohr (Audubon Nature Center) described the life history of *Eurycea longicauda*; W. W. Varnedoe (Huntsville, Ala.) presented a study of the brooding of *Plethodon g. glutinosus*; and Joe Gorman (St. Louis University) discussed the evolution of cave salamanders. N. B. Causey of Fayetteville, Ark., spoke on speciation in the cave milliped *Scoterpes*, and Kenneth Christiansen of Grinnell College gave an outline of the genus *Sinella* in North American caves. The biologic session was concluded with a report on the cave beetles of Tennessee and Kentucky, by T. C. Barr, Jr., of Tennessee Polytechnic Institute.

The banquet speaker at the convention was Walter B. Jones, state geologist of Alabama, who is completing a monograph on the caves of Alabama.

Officers elected for the coming year are as follows: president, Brother G. Nicholas, Notre Dame University; vice president for administration, D. N. Cournoyer, Washington, D.C.; vice president for organization, D. F. Black, Chattanooga, Tenn.; vice president for publications, T. C. Barr, Jr., Tennessee Polytechnic Institute; vice president for research, G. W. Moore, U.S. Geological Survey; and treasurer, Barbara Munson, Chattanooga, Tenn.

W. E. Davies (U.S. Geological Survey, Washington, D.C.) will continue as editor of the *Bulletin* of the National Speleological Society. The current issue of the *Bulletin* contains a comprehensive index to its first 20 volumes.

Chairman of this convention, which in addition to the technical sessions offered field trips to caves in the Ozark Mountains, was Oscar Hawksley of Central Missouri State College. The 1960 convention of the society will be held in Carlsbad, N.M., and will include field trips to Carlsbad Caverns and other caves of the Guadalupe Mountains. Convention chairman will be J. K. Baker of the National Park Service.

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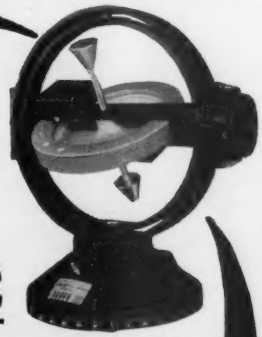

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Forthcoming Events

December

26–30. American Assoc. for the Advancement of Science, annual, Chicago, Ill. (R. L. Taylor, AAAS, 1515 Massachusetts Ave., NW, Washington 5.)

The following 46 meetings are being held in conjunction with the AAAS annual meeting.

AAAS Committee on Science and the Promotion of Human Welfare (B. Commoner, School of Botany, Washington Univ., St. Louis 5, Mo.). 27 Dec.

AAAS Cooperative Committee on the Teaching of Science and Mathematics (Brother G. Nicholas, Dept. of Biology, Univ. of Notre Dame, Notre Dame, Ind.). 27 Dec.

Academy Conference (A. M. Winchester, Stetson Univ., De Land, Fla.). 27–28 Dec.

Alpha Epsilon Delta (M. L. Moore, 7 Brookside Circle, Bronxville, N.Y.). 29 Dec.

American Assoc. of Clinical Chemists (A. Dubin, Cook County Hospital, Chicago 12, Ill.). 26–27 Dec.

American Geophysical Union (W. C. Krumbein, Dept. of Geology, Northwestern Univ., Evanston, Ill.). 28 Dec.

American Meteorological Soc. (K. Spengler, 3 Joy St., Boston, Mass.).

American Nature Study Soc. (E. L. Will, State Univ. Teachers College, Oneonta, N.Y.). 26–30 Dec.

American Physiological Assoc. (F. A. Hitchcock, Ohio State Univ., Columbus). 28 Dec.

American Political Science Assoc. (J. Robinson, Dept. of Political Science, Northwestern Univ., Evanston, Ill.). 28 Dec.

American Psychiatric Assoc. (E. L. Bliss, General Hospital, Salt Lake City, Utah). 28–29 Dec.

American Soc. of Criminology (D. E. J. MacNamara, New York Inst. of Criminology, Inc., New York 36). 28–29 Dec.

American Soc. of Naturalists (A. D. Hasler, Dept. of Zoology, Univ. of Wisconsin, Madison). 27–28 Dec.

American Soc. of Plant Taxonomists (L. R. Heckard, Dept. of Botany, Univ. of Illinois, Urbana). 28–30 Dec.

American Sociological Soc. (J. S. Coleman, Dept. of Sociology, Univ. of Chicago, Chicago 37, Ill.). 28–29 Dec.

American Statistical Assoc. (R. F. Winch, Dept. of Sociology, Northwestern Univ., Evanston, Ill.). 29–30 Dec.

Association of American Geographers (A. Cutshall, Univ. of Illinois, Navy Pier, Chicago 11). 29 Dec.

Association for Computing Machinery (W. F. Cahill, Goddard Space Flight Center, Silver Spring, Md.). 29 Dec.

Astronomical League (E. Halbach, 2971 S. 52 St., Milwaukee 19, Wisc.). 26 Dec.

Beta Beta Beta (Mrs. F. G. Brooks, P.O. Box 515, Ansonia Station, New York 23). 27–28 Dec.

Chicago Acad. of Sciences (R. A. Edgren, Chicago Acad. of Sciences, 2001 N. Clark St., Chicago 14, Ill.). 29-30 Dec.

Conference on Scientific Communications (G. L. Seielstad, Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.). 28–29 Dec.

Conference on Scientific Manpower (T. J. Mills, National Science Foundation, Washington 25). 28 Dec.

Ecological Soc. of America (W. C. Ashby, Dept. of Botany, Univ. of Chicago, Chicago 37, Ill.). 28–30 Dec.

Honor Soc. of Phi Kappa Phi (L. R. Guild, 634 S. Western Ave., Los Angeles 5, Calif.). 30–31 Dec.

Illinois Geographical Soc. (Miss M. Grant, Morton Junior College, Cicero, Ill.). 28 Dec.

Institute of Management Sciences (M. M. Flood, College of Engineering, Univ. of Michigan, Ann Arbor). 29 Dec.

Metric Assoc. (J. T. Johnson, Ravenswood YMCA, 1725 Wilson Ave., Chicago 40, Ill.).

Mycological Soc. of America (D. P. Rogers, Dept. of Botany, Univ. of Illinois, Urbana).

National Assoc. of Biology Teachers (H. E. Weaver, 202 Men's Old Gym, Univ. of Illinois, Urbana). 26–30 Dec.

National Acad. of Economics and Political Science (J. Rothrock, Pan American Union, Washington 6). 29 Dec.

National Assoc. for Research in Science Teaching (J. C. Mayfield, Univ. of Chicago, Chicago 37, Ill.). 26–30 Dec.

National Assoc. of Science Writers (P. Fraley, Evening Bulletin, Philadelphia, Pa.). 27 Dec.

National Geographic Soc. (W. R. Gray, NGS, 16 and M Sts., NW, Washington 6). 30 Dec.

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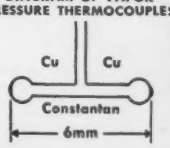

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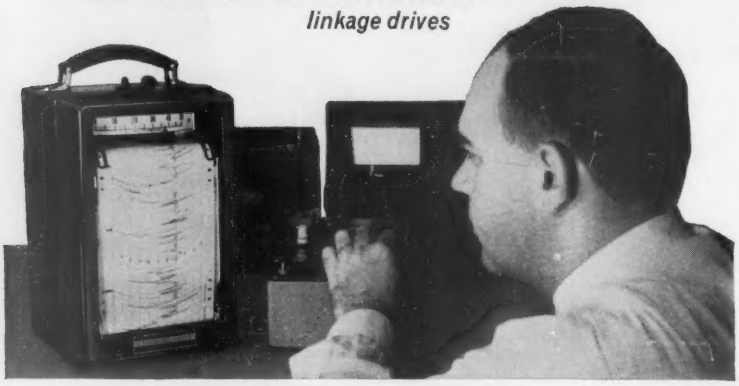

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National Soc. for Medical Research (R. A. Rohweder, NSMR, 920 S. Michigan Blvd., Chicago 5, Ill.). 29 Dec.

National Speleological Soc. (T. C. Barr, Jr., Tennessee Polytechnic Inst., Cookeville, Tenn.). 28 Dec.

Philosophy of Science Assoc. (W. A. R. Ley, Roosevelt College, Chicago, Ill.). 28 Dec.

Scientific Research Soc. of America (D. B. Prentice, 56 Hillhouse Ave., New Haven 11, Conn.). 29 Dec.

Sigma Delta Epsilon (Miss E. S. Anderson, Stratford Hotel, 25 E St., NW, Washington, D.C.). 26–30 Dec.

Society for General Systems Research (R. L. Meier, Mental Health Research Institute, Univ. of Michigan, Ann Arbor).

Society for the History of Technology (M. Kronzberg, Dept. of History, Case Inst. of Technology, Cleveland, Ohio).

Society of the Sigma Xi (T. T. Holme, 56 Hillhouse Ave., New Haven 11, Conn.). 29 Dec.

Society of Systematic Zoology (R. E. Blackwelder, Southern Illinois Univ., Carbondale). 26–30 Dec.

Tau Beta Pi Assoc. (R. H. Nagel, Univ. of Tennessee, Knoxville). 27 Dec.

United Chapters of Phi Beta Kappa (C. Billman, 1811 Q St., NW, Washington, D.C.). 29 Dec.

27–30. American Anthropological Assoc., Mexico City. (W. S. Godfrey, Jr., Logan Museum, Beloit College, Beloit, Wisc.)

27–30. American Astronomical Soc., Cleveland, Ohio. (J. A. Hynek, Smithsonian Astrophysical Observatory, 60 Garden St., Cambridge 38, Mass.)

27–30. American Folklore Soc., Mexico City. (MacE. Leach, 110 Bennett Hall, Univ. of Pennsylvania, Philadelphia 4.)

27–30. American Statistical Assoc., Washington, D.C. (D. C. Riley, 1757 K St., NW, Washington 6.)

27–30. Institute of Mathematical Statistics (weather control), Washington, D.C. (J. Neyman, Statistical Lab., Univ. of California, Berkeley 4.)

28–29. American Chemical Soc. (Div. of Industrial and Engineering Chemistry), symp., Baltimore, Md. (M. A. H. Emery, ACS, 18 and K Sts., NW, Washington D.C.)

28–29. Industrial Relations Research Assoc., Washington, D.C. (E. Young, Sterling Hall, University of Wisconsin, Madison.)

28–29 Mechanism of Interfacial Reaction, American Chemical Soc., annual symp, Baltimore, Md. (H. E. Hoelscher, Chemical Engineering Dept., Johns Hopkins Univ., Baltimore, Md.)

28–29. Lepidopterists' Soc., 10th annual, Ann Arbor, Mich. (E. G. Voss or W. H. Wagner, Dept. of Botany, Univ. of Michigan, Ann Arbor.)

28–29. Northwest Scientific Assoc., Spokane, Wash. (W. B. Merriam, Dept. of Geography, State College of Washington, Pullman.)

28–30. American Economic Assoc., Washington, D.C. (J. W. Bell, Northwestern Univ., 629 Noyes St., Evanston, Ill.)

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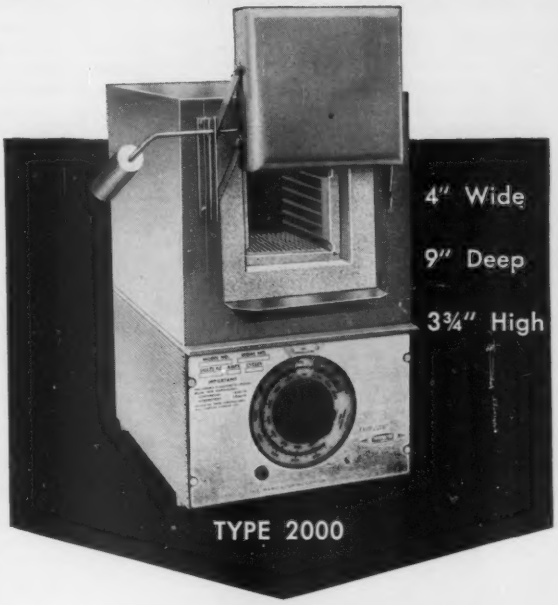

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28–30. American Physical Soc., Pasadena, Calif. (K. Darrow, APS, Columbia Univ., 116 St. and Broadway, New York, N.Y.)

28–30. Econometric Soc., Washington, D.C. (R. Ruggles, Dept. of Economics, Yale Univ., New Haven, Conn.)

28–30. Western Soc. of Naturalists, Los Angeles, Calif. (Y. U. Amrein, Dept. of Zoology, Pomona College, Claremont, Calif.)

28–31. Phi Delta Kappa, Columbia, Mo. (A. G. Clark, 316 Dalzell Ave., Ben Avon, Pittsburgh 2, Pa.)

28–16. Bahamas Surgical Conf., Nassau. (B. L. Frank, P.O. Box 4037, Fort Lauderdale, Fla.)

January

1–5. Electrochemical Soc., Chicago, Ill. (Electrochemical Soc., Inc., 216 W. 102 St., New York 25.)

1–5. Institute of Geographers, annual conf., Southampton, England. (A. E. Smailes, Queen Mary College, Univ. of London, Mile End Rd., London, E.1.)

3–9. Indian Science Cong. Assoc., 4th, Bombay. (B. W. Prasad, ISCA, Lakshmi Niwas, Georgetown, Allahabad 2, India.)

5–7. Recent Mechanical Engineering Developments in Automatic Control, symp., London, England. (Institution of Mechanical Engineers, 1 Birdcage Walk, London, S.W.1.)

6–8. Northeastern Weed Control Conf., 14th annual, New York, N.Y. (M. G. Wiltse, Chairman, Public Relations Committee, Dow Chemical Co., 916 Shoreham Bldg., 15 and H Sts., NW, Washington 5, D.C.)

7–10. Radioactive Isotopes, 4th intern. symp., Bad Gastein, Austria. (R. Hofer, Isotopen-Laboratorium, II. Medizinische Universitäts Klinik, 13, Garnisongasse, Vienna 9, Austria.)

8–11. Sanitary Engineering Conf., ASCE, Cincinnati, Ohio. (E. S. Kirkpatrick, ASCE, 33 W. 39 St., New York 18.)

11–13. American Acad. of Allergy, Hollywood-by-the-Sea, Fla. (J. O. Kelley, 756 N. Milwaukee St., Milwaukee 2, Wisc.)

11–13. Arctic Geology, 1st intern. symp., Calgary, Alberta, Canada. (D. W. R. Wilson, Arctic Symposium Committee, P.O. Box 100, Calgary, Alberta, Canada.)

11–13. Reliability and Quality Control, natl. symp., Washington, D.C. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

11–15. Society of Automotive Engineers, annual, Detroit, Mich. (R. W. Crory, Meetings Operation Dept., SAE, 485 Lexington Ave., New York 17.)

11–25. Effects of Atomic Radiation, New York, N.Y. (R. Appleyard, Scientific Committee on the Effects of Radiation, United Nations, New York 17.)

12–15. Society of Plastics Engineers, 16th annual conf., Chicago, Ill. (T. A. Bissell, SPE, 65 Prospect St., Stamford, Conn.)

14–18. American Inst. of Mining, Metallurgical, and Petroleum Engineers, annual, New York, N.Y. (E. O. Kirkendall, AIMMPE, 29 W. 39 St., New York 18.)

17–30. Bahamas Medical Serendipity Conf., 2nd, Nassau. (B. L. Frank, P.O. Box 4037, Fort Lauderdale, Fla.)

18–21. American Astronautical Soc., 6th annual, New York, N.Y. (A. P. Mayernik, AAS, 6708 53 Rd., Maspeth 78, N.Y.)

19–21. American Meteorological Soc., 40th annual, Boston, Mass. (K. C. Spengler, 3 Joy St., Boston.)

19–21. Congenital Malformations, CIBA symp. (by invitation only), London, England. (G. E. W. Wolstenholme, 41 Portland Pl., London, W.1.)

21–23. American College of Surgeons, Louisville, Ky. (H. P. Saunders, 40 E. Erie St., Chicago 11, Ill.)

23–28. American Acad. of Orthopedic Surgeons, Chicago, Ill. (J. K. Hart, 116 S. Michigan, Chicago 3.)

24–29. American Rocket Soc., Princeton, N.J. (J. J. Harford, ARS, 500 Fifth Ave., New York 36.)

25–28. Institute of the Aeronautical Sciences, 28th annual, New York, N.Y. (IAS, 2 E. 64 St., New York 21.)

25–28. Plant Maintenance and Engineering Show, Philadelphia, Pa. (R. S. Wolcott, Clapp & Poliak, 341 Madison Ave., New York 17.)

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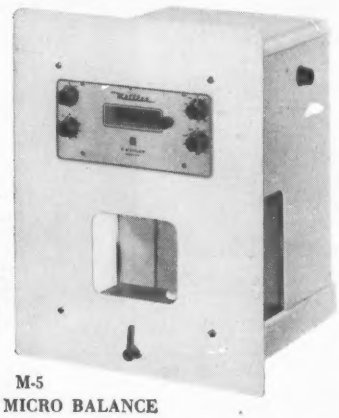

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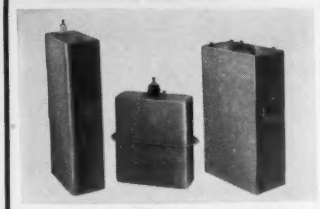

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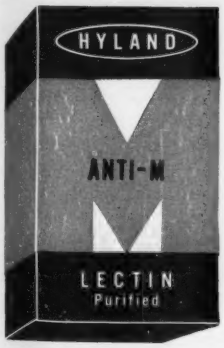

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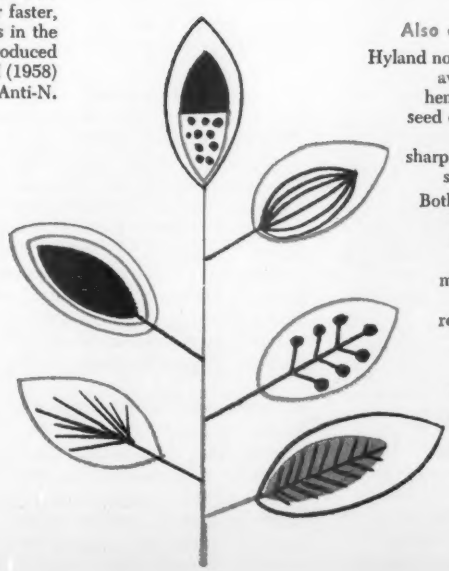

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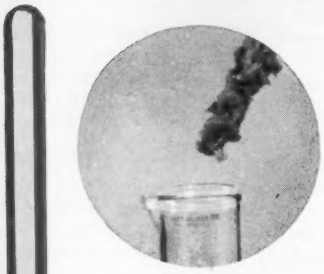

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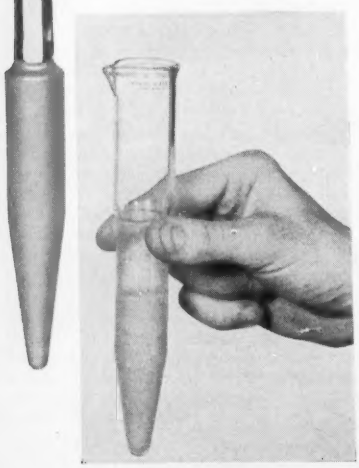

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■ MICRO-PIPETTER has a maximum capacity of 1 ml and will measure samples as small as 0.001 ml. Accuracy is said to be ±2 percent for a 0.001-ml sample and ±0.25 percent for a 0.1-ml sample. The pipette is hydraulically operated with integral well and valve assembly. All metal parts are stainless steel or aluminum; the pipette itself is Kel-F. Vertical travel is 7½ in.; horizontal travel is 42 in. (Nuclear-Ohio, Inc., Dept. Sci243, Bay Village, Ohio)

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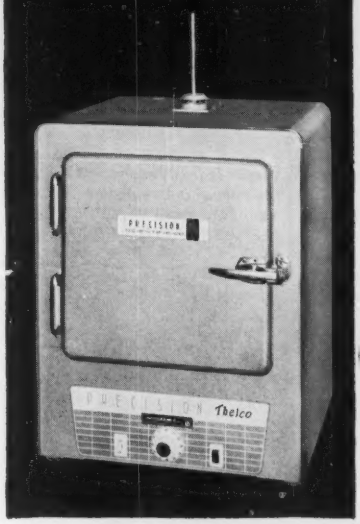

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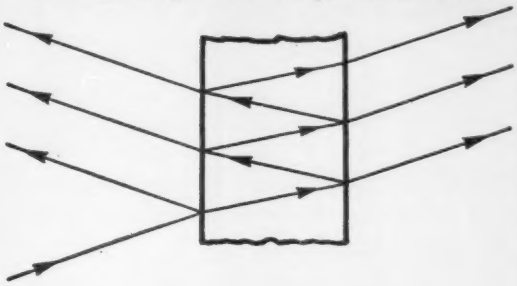

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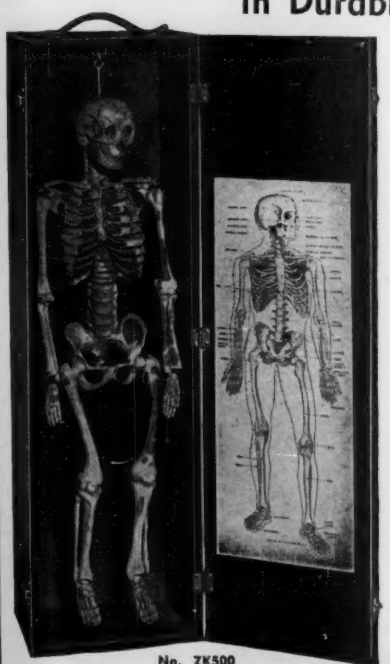

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JOSHUA STERN

National Bureau of Standards, Washington, D.C.

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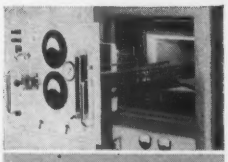

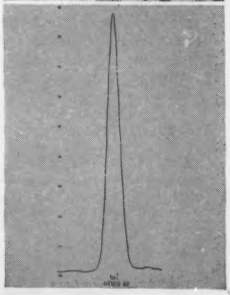

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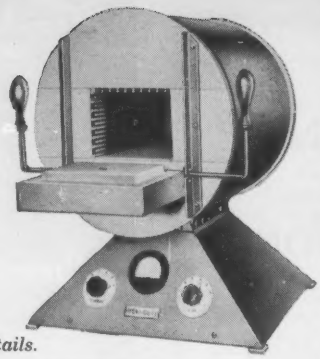

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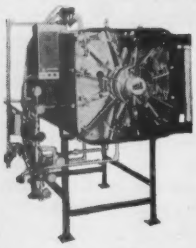

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Letters

(Continued from page 1530)

values of zero and 18,000 tons. On 16 July, after the test, our first measurement of what had really happened gave 20,000 tons. That morning General Groves communicated this figure to the War Department, for transmission to the Secretary of War and the President, who were in Potsdam, meeting with representatives of the United Kingdom and the U.S.S.R.

I should perhaps add that when a scientific panel met with the Secretary of War's Interim Committee on 31 May 1945, Secretary Stimson and General Marshall were both present. I remember reporting that we expected one model of the bomb to be many times more powerful than the other, but that we were so uncertain of our ground that they might turn out in quite opposite order. I also remember that on that occasion we discussed a possibility, which had been reported to the Government in 1942, of developing bombs in the multi-megaton range by the use of fissionable material, heavy hydrogen, and natural uranium. Here, too, our early designs were to change with time.

ROBERT OPPENHEIMER

Institute for Advanced Study, Princeton, New Jersey

I have seen a copy of the letter which Robert Oppenheimer has written you correcting statements in Amrine's book, which were developed in E. U. Condon's review (which I have not seen).

I have no way of knowing whether Amrine was misled by statements on the subject made in my book *Churchill, Roosevelt, Stalin*. But I have a sense of responsibility for sharing in the diffusion of this erroneous impression of the anticipated explosive power of the atomic bomb. How I came to overlook the first paragraph of General Groves' memorandum to General Marshall quoted by Oppenheimer I do not understand. I suppose an appropriate penalty —the ultimate proof of my mistake— would be to be blown up by one.

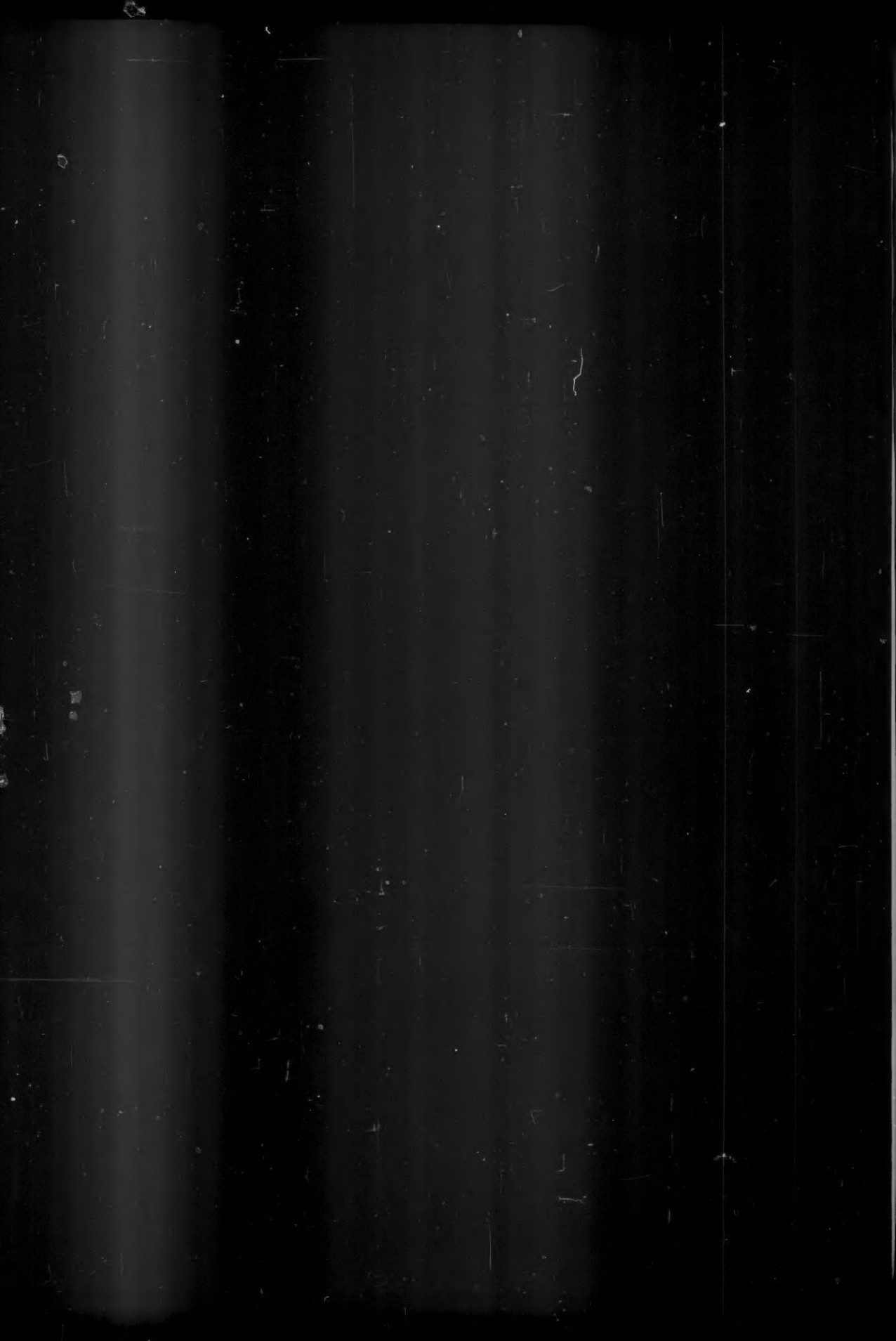
HERBERT FEIS

York, Maine

I would like to correct some of the erroneous impressions a reader would gain from E. U. Condon's "review" of Michael Amrine's book *The Great Decision*, which appeared in a recent issue of *Science*.

This "review" goes far afield from the content of the book, and this despite a confession of little first-hand knowledge. While such frankness may be refreshing, equal frankness would have made Condon add the statement that he is not particularly fond of me.

PAGES 1593-1594, ADVERTISEMENT CARD



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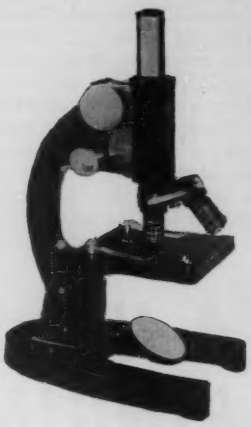

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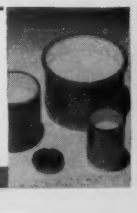

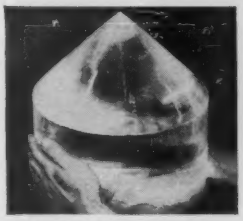

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I would not bother to answer Condon except for the fact that a publication such as *Science* has seen fit to print his "review" without checking his alleged facts. Many are so preposterous as to be obviously incorrect. The conclusions supposedly drawn therefrom present me in an entirely false position.

Condon's charge that I worked "to hobble and frustrate cooperation" with the British simply is not true. Because neither I nor anyone else could even guess at that time how the atomic future might unfold, because I felt that I had no right to give away information developed with United States funds, and because I believed that orderly procedures were essential in such a large and widespread effort, I did not want the previously highly informal communications to continue. These had not been unreasonable before the United States entered upon its major atomic effort. I felt that now specific presidential approval was required for any significant passing of information. I was not alone in this opinion. An executive agreement between President Roosevelt and Prime Minister Churchill, defining British-American relationships in this area, was the first essential to the formalization of the interchange of information.

Yet, it was not until the Quebec Conference of August 1943 that the necessary basic agreement was reached. I was not responsible for the fact that this agreement was not arrived at sooner. As soon as it was signed, proper arrangements were promptly made and the furnishing of information was controlled in accordance with the terms of the Quebec Agreement.

As to Chalk River, Condon ignores the fact that its parent organization was already being established at Montreal before I was placed in charge of the Manhattan project. This laboratory was never a part of the American project. A number of its key personnel were Free French, and France was still under German control. This added to our difficulties. In spite of these complications, the Canadian-British effort always received essential information from us to the extent necessary for the work it was carrying on. The Canadian Government always seemed satisfied with this cooperation. The Royal Commission appointed to investigate Russian espionage in Canada in its report of 27 June 1946 said (page 617):

> From the beginning there was the closest cooperation in scientific research between Canada, the United Kingdom, and, later the United States. While some secrets were not fully shared, as in the case of some details concerning the atomic bomb, the results of continuing research work by scientists in one country were in almost all cases at once communicated to their opposite numbers in the other two.

All available essential data and estimates respecting the bomb were made known to our policy makers when decisions were being made on the use of the bomb. General Marshall, Secretary Stimson, and the President (Roosevelt and later Truman) were kept informed as to the probable effect of the bomb on the conduct of the war. It was my responsibility to keep General Marshall and Secretary Stimson fully informed as to the changes in scientific thinking, including my own, on the probable power of the bomb. And I fulfilled that responsibility.

It is true that I did not know enough physics to insure the accuracy of any estimate, but, I might add, neither did anyone else. We simply did not have in the Manhattan organization a scryer of sufficient ability to do this. The estimates included in my memorandum of 30 December 1944 were based on my latest discussions with, and information from, Oppenheimer and his associates at Los Alamos. I might add that as late as the middle of May 1945 the

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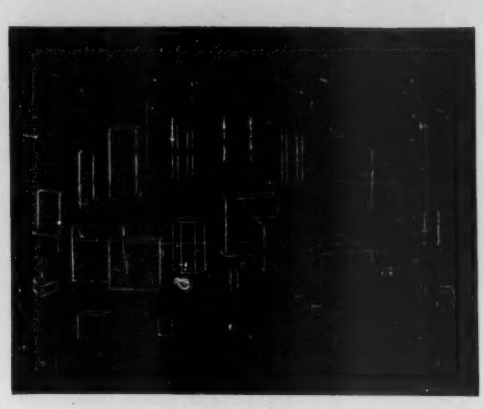

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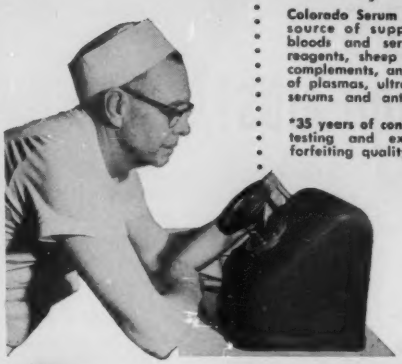

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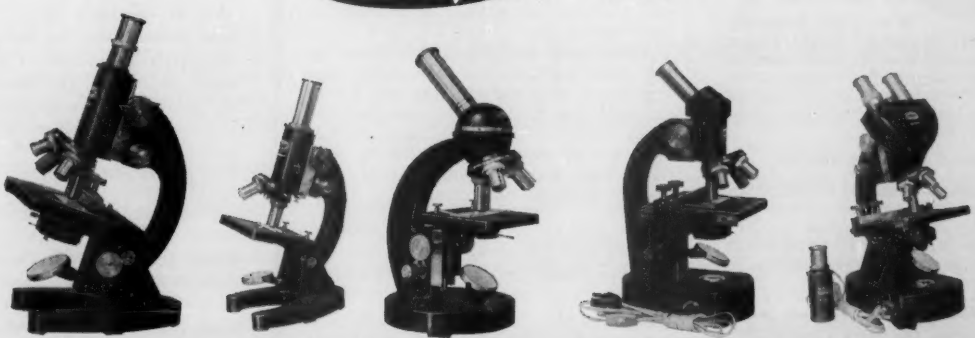

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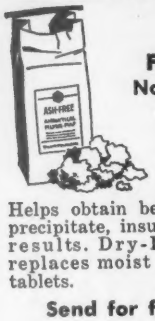

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responsible heads at Los Alamos felt that the explosive force of the first implosion-type bombs would fall somewhere between 700 and 1500 tons.

Actually my memorandum to General Marshall of 30 December 1944, of which Condon makes such a point, has been completely misrepresented—and this is not the first time, although, with a few omissions (all nonessential for the present discussions), it was published in full with the Yalta papers and is thus readily available to any responsible writer. The first part of this memorandum read as follows (the remainder dealt with informing Admiral Nimitz and the air commander in the Guam area as to the atomic possibilities):

> It is now reasonably certain that our operation plans should be based on the gun type bomb, which, it is estimated, will produce the equivalent of a ten thousand ton TNT explosion. The first bomb, without previous full scale test which we do not believe will be necessary, should be ready about 1 August 1945. The second one should be ready by the end of the year and the succeeding ones at . . . intervals thereafter.
>
> Our previous hopes that an implosion (compression) type bomb might be developed in the late spring have now been dissipated by scientific difficulties which we have not as yet been able to solve. The present effects of these difficulties are that more material will be required and that the material will be less efficiently used. We should have sufficient material for the first implosion type bomb sometime in the latter part of July. This bomb would have an effect which would be equivalent to about 500 tons of TNT. During the remainder of 1945 it is estimated that we can produce . . . additional bombs. The effectiveness of these should increase towards 1000 tons each as development proceeds and, if some of our problems are solved, to as much as 2500 tons.
>
> The plan of operations while based on the more certain more powerful gun type bomb also provides for the use of the implosion type bombs when they become available. . . . The time schedule must not be adversely affected by anything other than the difficulties of solving our scientific problems.

For a considerable period prior to this we had fully expected to use the gun-type bomb first and, as we did at Hiroshima, to use it without previous test. Actually, the reading of this memorandum by President Roosevelt was only a minor portion of the conference, and further information was given him later—the next day, I believe—by Secretary Stimson. That the President was fully informed is well illustrated by a statement of Secretary of State Stettinius, who, in his book *Roosevelt and the Russians*, mentioned his meeting with President Roosevelt shortly after this date, and the latter's

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telling him on this occasion that if a bomb were dropped on New York City at 42nd Street and Broadway, the resulting explosion would lay New York low.

President Truman was fully aware of the potential power of the bomb from the time that he had his first conference on it with Secretary Stimson and me on 25 April 1945. At this meeting the President was not shown the 30 December memorandum. He did see, among other papers, Secretary Stimson's memorandum of 25 April, the first paragraph of which read as follows:

"Within four months we shall in all probability have completed the most terrible weapon ever known to human history, one bomb of which could destroy a whole city" (Stimson and Bundy, *On Active Service in Peace and War*, vol. 2, p. 635). Could anything have been clearer as to the import of the bomb?

From the very first, the messages to Potsdam were definite and clear as to the magnitude of the Alamogordo explosion. It was described in one of the cables as being visible for over 200 miles and audible for more than 50. Nothing could be further from the truth than the charge that there was any design to minimize the bomb.

I trust that because of the scientific reputation and value of your publication, because unanswered statements, no matter how unfounded, tend to become history, and because of the palpable injustice to me of Condon's "review," you will publish this letter in full.

LESLIE R. GROVES

Darien, Connecticut

In response to the editor's invitation to comment on the letters from J. R. Oppenheimer and General Groves, I would say that I welcome the attention thus focused on Amrine's book. If there are errors in that book, this underscores the need for scholarly historical research on the full story of uranium bomb development.

Groves confirms that he did restrict exchange of information with our British partners—exchange which had been well established before he came on the project. More than a year and a half was lost before Roosevelt and Churchill reestablished that cooperation, in August 1943. How much delay resulted from that unfortunate policy will need to be assessed when the real history is written.

When that history is written one of the least important parts will be that which says whether General Groves is particularly fond of me or vice versa. A complete history will tell of the frantic efforts of one man to retain personal control of atomic energy in America by trying to rush the May-

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Johnson bill through Congress; of how he was foiled in this by some of the scientists; and of his embittered efforts to take revenge. Such a history will examine carefully whether these things were related to the doings of the House Committee on Un-American Activities in 1948 and 1949, which deprived this country of the services of so many brilliant young American scientists.

E. U. CONDON
Washington University, St. Louis, Missouri

Radionuclides and Bone Cancer

A serious error exists in J. G. Kaplan's recent letter (*1*). It was stated that the Russians had observed bone cancers developing in dogs about 3 years after the injection of 0.1 microcurie of strontium-90 per kilogram. Actually, the radionuclide used in these Russian studies was not strontium-90, as erroneously reported by Engstrom *et al.* (*2*), but the much more dangerous thorium-228 (*3*).

The injected amounts of strontium-90 which it has been proved cause bone cancer are much higher than 0.1 μc/kg. Finkel (*4*) found that the incidence of osteogenic sarcomas in 90 mice injected with 44 μc of strontium-90 per kilogram was somewhat higher (6 percent) than that in 150 controls (2 percent), but the probability of this being due to chance occurrence was 20 to 30 percent. In a current study in our laboratory, 60 beagles have been injected with from 0.5 to 100 microcuries of strontium-90 per kilogram. Thus far only one dog, injected with 94 μc/kg, has developed a bone tumor. These results do not imply that lesser amounts of strontium-90 are without effect. However, they do illustrate the enormous difficulty in experimentally determining the consequences of very small injections of strontium-90, such as 0.1 μc/kg.

The maximum permissible body burdens of strontium-90 and radium-226 should be set so as to give the same probability (or improbability) of causing undesirable effects. If the ratio of these limits is based on the observed biological effects of strontium-90 and radium-226 in experimental animals, the maximum permissible body burdens, for occupational workers, of 2 microcuries of strontium-90 and 0.1 microcurie of radium-226 correspond fairly well.

In view of Kaplan's opinion of the "obvious impertinence" of physicists in biological questions, it seems strange that he would base the heart of his argument on the theoretical calculations of Rolf Björnerstedt, who is a physicist.

C. W. MAYS
Division of Radiobiology, University of Utah, Salt Lake City

References

1. J. G. Kaplan, *Science* **130**, 728 (1959).
2. A. Engstrom, R. Björnerstedt, C. J. Clemedson, A. Nelson, *Bone and Radiostrontium* (Wiley, New York, 1957), p. 133.
3. R. Björnerstedt, in a letter (9 July 1959) citing results reported in *Conference on the Remote Consequences of Injuries Caused by the Action of Ionizing Radiation*, F. G. Krotkov *et al.*, Eds. (State Med. Lit. Press, Moscow, 1956).
4. M. P. Finkel, *Science* **128**, 637 (1958).

Meteorology for Non-Science Majors

There is general agreement that all college students should have an experience in science before they receive their diplomas. Very rarely, it seems, is meteorology recommended as one of the courses the student should take to satisfy his science requirement. This is regrettable in view of the fact that meteorology has within it all the ele-

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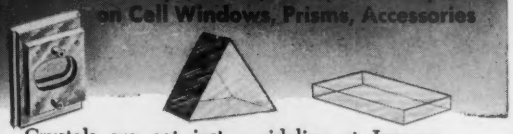

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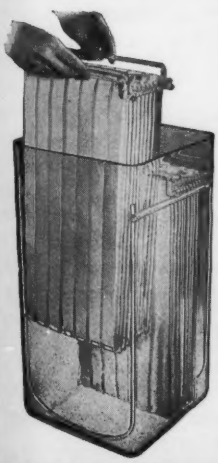

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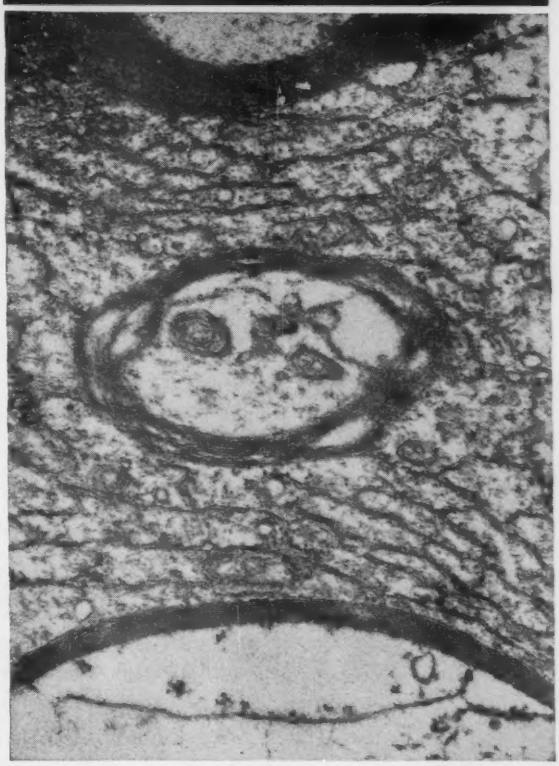

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ments which a science course for the non-science major should have.

Of course there are reasons for the present situation. People have been concerned about the weather since "the year 1," yet the problems involved in making enough observations of the atmosphere to find out what is going on and then devising ways of handling and digesting the masses of data have been so immense that modern meteorology can be considered a rather young branch of science.

Despite the vast meteorological training program of World War II, only a small percentage of these trained men went back into academic life after the war, and of those who did, only a fraction found academic positions in which it was possible to teach meteorology.

The professional academic meteorologist still finds it difficult to disengage himself from the stereotype of the fumbling-bumbling weatherman fostered by the cartoonists in the public press. And his timid dean hesitates, on the basis of scientific respectability, to encourage development of a course in which (he opines) the subject matter is more of an art than a science.

Despite difficulties such as these, meteorology does seem to be coming of age as a valid academic subject studied by many more than just a few specialists. It is of this that I wish to speak, stating what appears to be a case for meteorology.

If a student who is a non-science major is to have only a fleeting experience of science, we first might ask what elements his experience should contain. Certainly his science course should have high interest value; it should leave him with an increased understanding of science; it should illustrate general principles in such a way that their broad applicability may be perceived; it should give him accurate information about the way in which science relates to human activity; it should have maximum carry-over value with respect to situations which he will encounter in later years; and, finally, it should not involve just an accumulation of facts—it should be developed around an integrative theme which provides coherence and continuity. How does meteorology rate according to these several criteria?

1) Every person lives out his life at the bottom of the "sea of air and water vapor" which produces the weather. The weather is of great interest to everyone because it necessarily affects everyone. Therefore it seems to make very good sense for an educated person to have an understanding of the circumstances under which the several phenomena—wind, cloud, rain, lightning, and so on—are produced, and the reasons for them.

2) Meteorology has high carry-over value. The person who learns to identify clouds and to read these "signposts of the sky" will have gained access to a source of lifelong enjoyment denied to other people. Each hour of each day holds interest for one who has become familiar with clouds and their portent.

3) Meteorology is a subject which beautifully illustrates general physical principles. In discussing energy and its transformations, an instructor can start with mass-energy transformations which take place in the sun's interior, lead the student through application of radiation laws across 93 million miles of space to the outer edge of the earth's atmosphere, follow the diminution of the solar beam through the atmosphere, apply the laws of motion to illustrate how the atmospheric circulation is maintained, and so forth.

4) In meteorology, excellent examples of the way pure science relates to human activity are legion. For example, the tornado represents concen-

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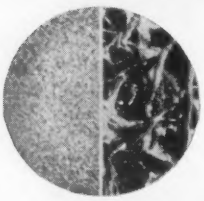

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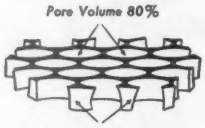

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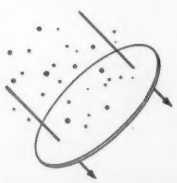

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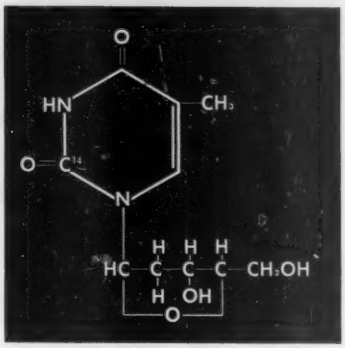

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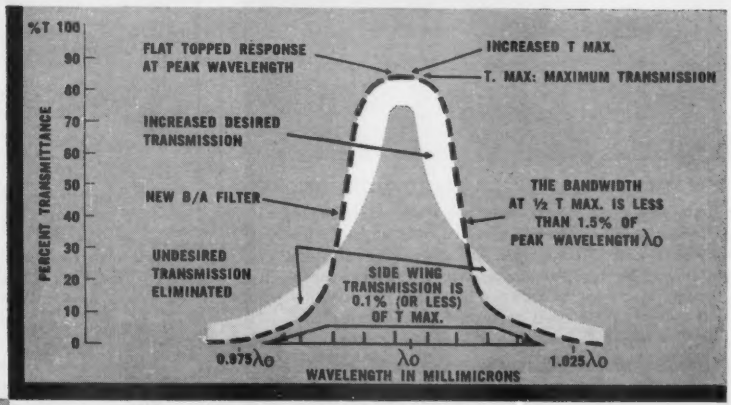

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Meteorology should be much more widely offered, and students who are non-science majors should be encouraged to take this course as a satisfying means of completing their physical-science requirement.

JOHN A. DAY

Linfield College,
McMinnville, Oregon

Arctic Waters

Regarding the report entitled "Tritium tracer in Arctic problems," by Giletti and Kulp [*Science* **129**, 901 (1959)] and the subsequent exceptions taken by Barnes and Coachman [*Science* **130**, 273 (1959)], I am not sure whether I am lessening or adding to the confusion with the following remarks, but there are some factors very pertinent to the matter which I feel should be brought out.

As Barnes and Coachman pointed out, the curves in Giletti and Kulp's Fig. 1 do not agree with the reference (*6*) cited in the figure's caption. The figure presents temperature-depth curves for "Icicle" stations, 2, 5, 10, and 11. The first two curves were derived not from reference *6* but rather from reference *5*, cited in the text [namely, L. V. Worthington, *Woods Hole Oceanog. Inst. Tech. Rept. 53-92* (1953)]. The other two curves were drawn from data gathered by Goldstein in 1955. I am not aware that the curves from the last two stations have appeared in previous literature, but the data received some small distribution.

Barnes and Coachman have used a bottom temperature read from the curve for station 11 to show that this water, if it were a mixture of Atlantic water and arctic surface water as proposed by Giletti and Kulp, was at best only 20 percent arctic and 80 percent Atlantic water. Giletti and Kulp replied that this accorded with their theory.

I should like to point out two items. First, the bottom temperature shown in the station-11 curve is actually an extrapolated value, the deepest observation having been made 22 meters above the bottom. This extrapolated bottom temperature is about +0.1°C; the deepest observation shows a temperature of +0.21°C. I am not sure that other extrapolators would have drawn the curve in quite the same manner as it appears in the Giletti and Kulp report.

The second item is, I believe, the crux of the matter. The tritium sample which led Giletti and Kulp to their conclusions was collected at a depth of 400 meters at a location very close to station 11. Therefore it would seem to be only proper to use the interpolated 400-meter temperature of +0.35°C given by Giletti and Kulp for station 11 in carrying out the computations proposed by Barnes and Coachman for figuring the percentages of Atlantic and arctic surface waters.

If this is done, we find that if surface water having a temperature of −1.9°C (which it would have if the salinity concentration were to be raised the requisite amount by freezing) is mixed, in

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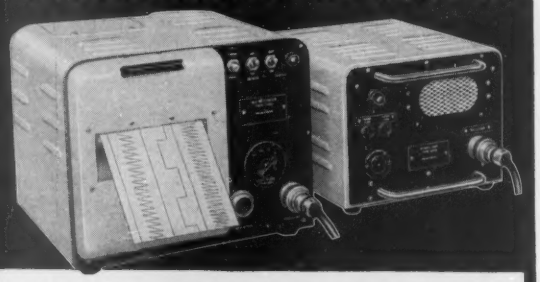

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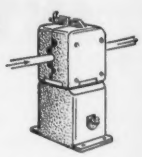

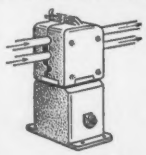

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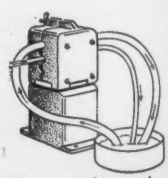

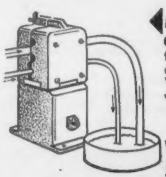

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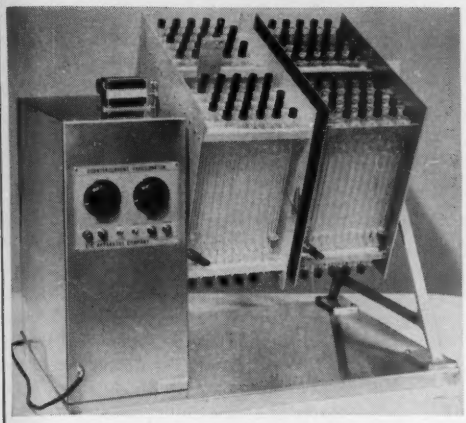

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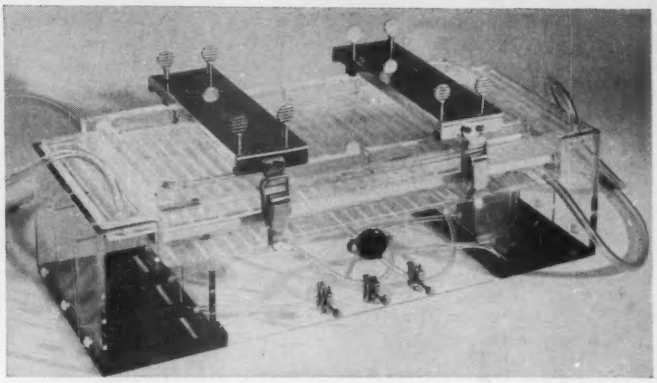

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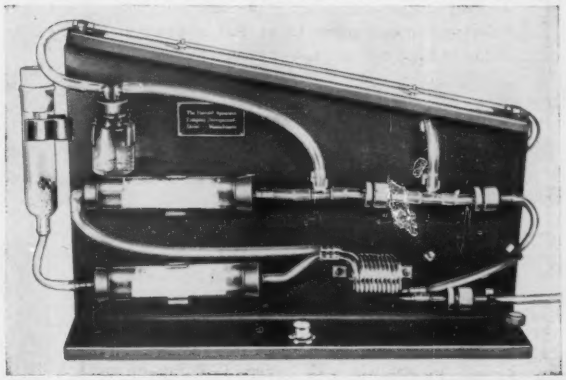

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sinking along the archipelago slope, with water of Atlantic origin having a temperature of +0.50°C, a resulting mixture with a temperature of +0.35°C at 400 meters would consist of nearly 94 percent Atlantic water and only about 6 percent locally formed water.

This would seem to make Giletti and Kulp's point (iv), that "a new source of the deeper water of the Arctic Ocean was found to be in the Canadian archipelago," sound a bit pretentious, especially as it is based on a single tritium measurement the results of which, as Barnes and Coachman point out, tend to support the more generally accepted theory nearly as strongly as they suggest the Giletti and Kulp conclusion.

WILLIAM G. METCALF
Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

We wish to thank W. G. Metcalf for his comments on our report "Tritium tracer in Arctic problems" and our subsequent exchange of letters with Barnes and Coachman. The point under discussion is our interpretation of the high value of tritium concentration found in a sample of Arctic Ocean water at a depth of 400 meters. In our explanation of this value we suggested that the supply of tritium occurred by the sinking of local surface water (normally richer in tritium) to this depth. We drew the analogy with other localities where sinking takes place as a result of freezing surface conditions. It would appear from Metcalf's calculation that only about 6 percent of the sea water in our 400-meter sample could have been derived from the surface as a result of such freezing.

In the generally accepted view of Arctic Ocean circulation the water at this depth is derived by the sinking under the arctic surface water of more highly saline water from the Atlantic. This water would then circulate cyclonically, traveling past Siberia before reaching our sample location north of Canada. If this were so, a very rapid rate of circulation would be required, and the net effect would be a generally high tritium content for all the deep water partaking of this pattern. As we pointed out in our reply to Barnes and Coachman, improbably high natural tritium production rates are required to maintain this concentration.

Metcalf suggests that the tritium data actually do "as Barnes and Coachman point out, tend to support the more generally accepted theory nearly as strongly as they suggest the Giletti and Kulp conclusion." On the contrary, there is a major contradiction between the tritium data and the expected tritium concentration. If the major cyclonic-flow pattern is excluded from this area, however, then all the data can be made to fit without the need for fresh supplies from the arctic surface. In this case, the Atlantic-derived water must flow in a fairly direct line to the sample location.

A possible solution to the problem may therefore be a more sharply defined version of the generally accepted theory. Should subsequent measurements support these original tritium observations, the theory may have to incorporate direct flow of Atlantic-derived water to the region north of Ellesmere Island. Further, if cyclonic flow exists over most of the Arctic Ocean, it must bypass the sample area.

Finally, we wish to stress the point that tritium can be used as a tracer to derive information on mixing rates in the Arctic Ocean. The present limited amount of data is as yet insufficient for drawing firm conclusions.

BRUNO J. GILETTI
J. LAURENCE KULP
Lamont Geological Observatory, Torrey Cliffs, Palisades, New York

Note

This letter is the Lamont Geological Observatory Contribution No. 386.

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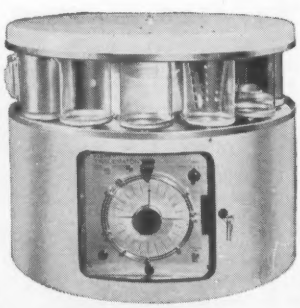

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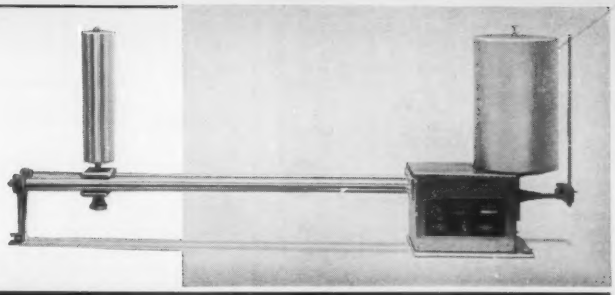

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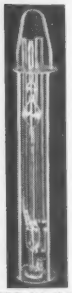

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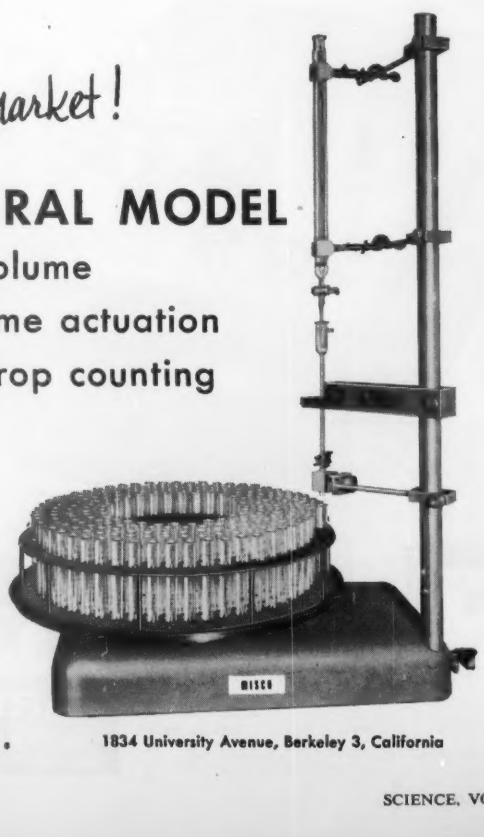

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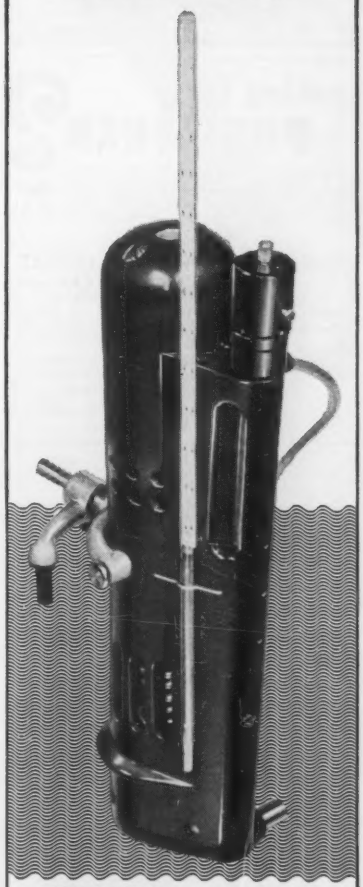

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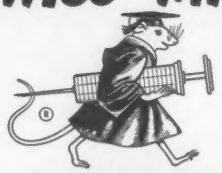

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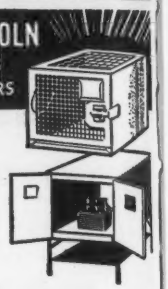

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Operation is completely automatic. You simply place knife in holder, apply abrasive powder, set automatic timer and flip on switch. Knife holder will accommodate any knife up to and including 185 mm.

Ask your AO Sales Representative to show you how AO's New Automatic Microtome Knife Sharpener can reduce your laboratory expense . . . reduce your costly knife inventory . . . and assure you a sufficient stock of sharp knives on-hand, at all times.

A demonstration costs you nothing. Use the handy coupon for complete information.

American Optical Company

INSTRUMENT DIVISION, BUFFALO 15, NEW YORK

Dept. X-1

☐ Please send full information on the New AO Spencer Microtome Knife Sharpener.

☐ Please arrange a demonstration of the New AO Spencer Microtome Knife Sharpener.

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